The Engineer

LONDON, FRIDAY, JANUARY 24, 1941.

PUBLIC NOTICES

CROWN AGENTS FOR THE COLONIES

COLONIAL GOVERNMENT APPOINTMENTS

Applications from qualified candidates are INVITED for the following POST :—

MAINTENANCE ENGINEER REQUIRED by the Government of British Guiana for the Transport and Harbours Department for one tour of three years. Salary £600 a year. Free passages and, if married, for wife and children not exceeding four persons. Leave on full salary. Candidates must be fully qualified Civil Engineers and have had good training in Track Maintenance, embracing yards lay-out and the laying down of points and crossings.

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Firms of Contractors who specialise in this work are INVITED by the Wardens to APPLY for PERMISSION to TENDER for the REPAINTING of the BRIDGE during 1941. Applicants should give the names of engineers for whom they have carried out similar work and to whom reference can be made.

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The work is to be commenced during the first week in April and shall be completed, war conditions permitting, within three calendar months from April 1st, 1941.

Tenders are to be delivered to the office of the Bridge Clerk by the first post on February 18th, 1941, in a plain envelope, endorsed "Tender for Repainting Rochester Bridge."

The Wardens do not bind themselves to accept the lowest or any Tender.

P. T. BAKER,
Bridge Clerk.

18, Star Hill,
Rochester,
January, 1941. 7060

CITY OF COVENTRY

WATER DEPARTMENT

APPOINTMENT OF CHIEF ENGINEERING ASSISTANT

Applications are Invited from qualified engineers, not exceeding 40 years of age, for the POST of CHIEF ENGINEERING ASSISTANT, at a salary of £400, rising, subject to satisfactory service, by annual increments of £20 per annum, to a maximum of £500 per annum (Senior Grade (2) of the Council's Salary Scale), the first increment being due on the 1st April, 1942. There is, in addition, a temporary cost-of-living bonus at the rate of 6 per cent. upon the first £300 of salary per annum and 3 per cent. upon the remainder.

The appointment is to fill a vacancy on the permanent staff of the undertaking, but all appointments made during wartime are, under the Council's rules, to be temporary only and for the duration of the war, when the position will be reconsidered.

Candidates should be Chartered Civil Engineers with previous waterworks experience. The successful candidate will be required to take charge of the drawing-office and supervise the distribution side of the undertaking.

The person appointed will be required to pass a medical examination, to contribute on the approved scale to the Superannuation Fund established by the Council under the Superannuation Acts, and to devote the whole of his time to the duties of the appointment.

Applications, endorsed "Chief Engineering Assistant," stating age, qualifications, present occupation and experience, and accompanied by copies of not more than three recent testimonials, must be delivered at the office of the undersigned not later than Monday, the 3rd February, 1941. No form of application will be issued.

Canvassing, either directly or indirectly, will be a disqualification.

NORMAN J. PUGH,
A.M. Inst. C.E., M. Inst. W.E.,
Water Engineer and Manager.

The Council House,
Coventry,
16th January, 1941. 7062

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TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

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IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

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1940 No. 877
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AN OPENING OCCURS with a Firm of Mechanical Engineers for a GENERAL ASSISTANT to the DIRECTORS. One capable of dealing fully with inquiries and orders for Mechanical Power Transmission and similar specialities. The work is varied and concentrated. The firm is engaged at high pressure in war work on products in their own line, and the position therefore offers future prospects for an energetic man who would devote himself to the firm's interests.—Address in writing, giving age, salary asked, and the fullest possible details of career, &c., 7088, The Engineer Office. 7088 A

The Engineer

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PAPER ECONOMY

It has now become necessary, in order to maintain the normal circulation of THE ENGINEER, to print all advertisement pages on the Thin Paper hitherto used for the Foreign Edition.

So long as our diminishing stocks of thick paper will allow, the Home Edition Editorial pages will be printed on the usual paper, so that uniformity in bound volumes may be maintained.

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The Engineer

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Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

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THE PROPRIETORS of BRITISH PATENT No. 475,508, relating to "Improvements relating to Refractory Products," DESIRE to ENTER into NEGOTIATIONS with one or more firms in Great Britain for the SALE of the PATENT RIGHTS or for the GRANT of LICENCES to manufacture under royalty.—Enquiries to be addressed to D. YOUNG & CO., Chartered Patent Agents, 21, Bourne End Road, Northwood, Middlesex. 7061 H

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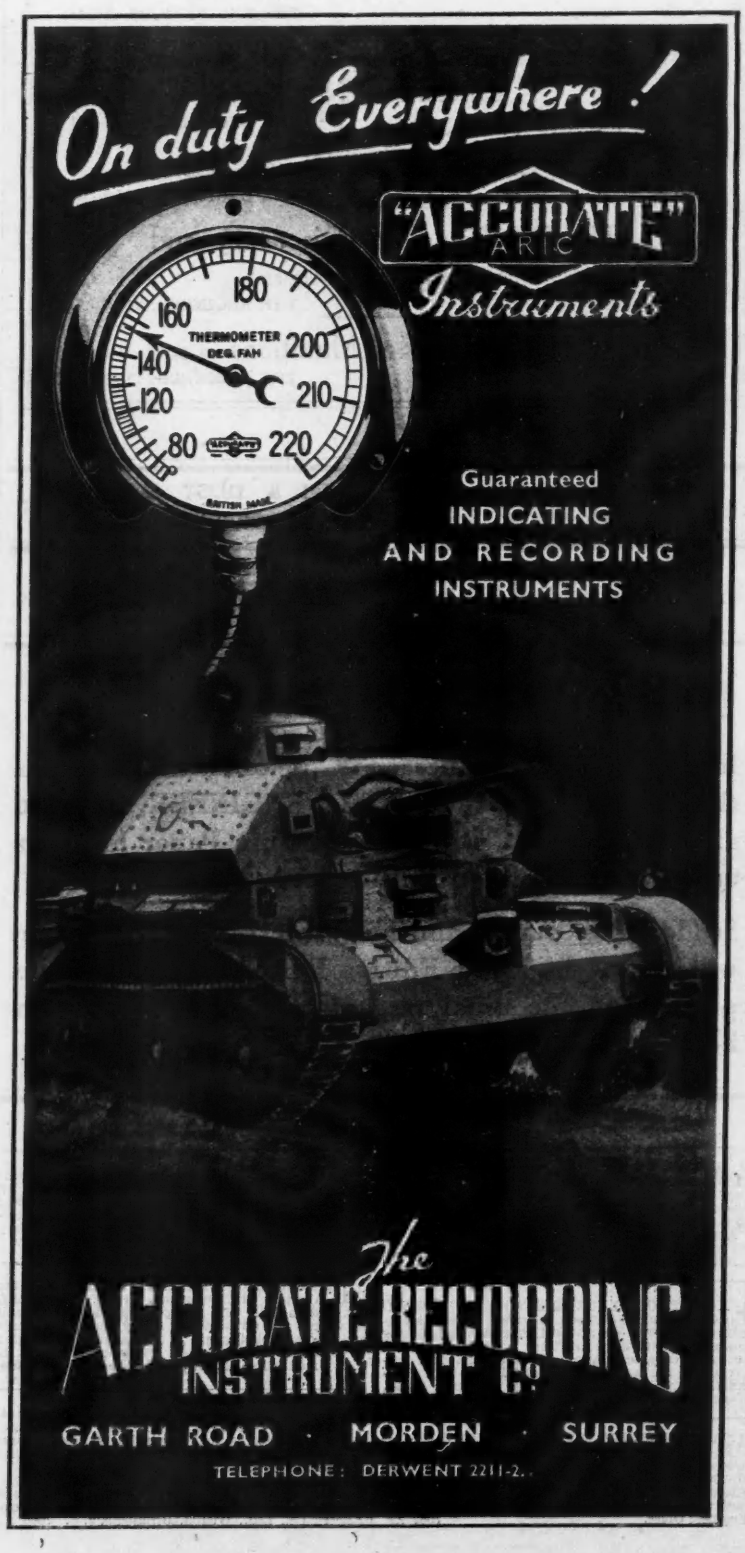

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BY
T. W. CHALMERS, D.Sc., M.I.Mech.E

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A Seven-Day Journal

Bom' ing Raids on Germany

PARTICULARS have been published this week by the Ministry of Information of the extent of Britain's air offensive against Germany. Excluding minor bombing and pamphlet dropping raids and also excluding raids against objectives in enemy-occupied territory, the total number of target areas attacked by the R.A.F. from the beginning of the war up to the end of December, 1940, exceeded 1400, as compared with about 900 recorded up to the end of September, 1940. The number of individual towns involved in these attacks is over 270. A map issued by the Ministry shows that the attacks have been delivered at those points where they will have the greatest immediate effect in crippling the enemy's war activities. The pattern of the falling bombs shown on this map reproduces with close similarity the pattern of the industrial framework on which Germany's war effort depends. Practically the only bare places on the map are those which do not include any major manufacturing centres. The heart of Germany's war production machine, in spite of all the efforts to move vulnerable factories towards the east, is still the congested Ruhr area from Munster in the north to Cologne in the south and with Essen at its centre. Over 500 raids have been carried out against this vital and heavily defended area. The Ruhr district lies within a radius of 350 miles from London. Germany's two other great munition areas lie at greater distances. A hundred miles higher up the Rhine is the Mannheim industrial district, stretching from Frankfort-am-Main to Stuttgart. Within this area chief attention has been paid to Mannheim, which was raided, up to the end of last year, thirty-four times. The third great centre of munitions works in Germany is the Leipzig district, within which a large portion of the enemy's synthetic oil plants is situated. Within this area lies Magdeburg, which has been raided nineteen times and Leuna and Leipzig, which between them have received sixteen visits. The most severely bombed town in Germany up to the end of December was Hamm, in the Ruhr, which suffered over eighty raids. Next comes Hamburg with sixty-one raids, Cologne with fifty-five, Bremen with fifty-two, and Gelsenkirchen with forty. Other towns or cities which have each received between thirty and forty raids are Mannheim, Duisburg-Ruhrort, Wilhelmshaven, Berlin and Kiel. An analysis of the objectives attacked during the raids shows that 459 attacks have been delivered against railways and communications, 317 against munition and aircraft works, military stores and power stations, 269 against docks and shipping, 254 against oil refineries and storage depôts, 199 against aerodromes and seaplane bases, and twenty-five against other objectives.

Two Allied Warships Launched

A NEW submarine to take the place of the famous "Orzel" has been built and launched in a British shipyard. She was named the "Sokol" ("Falcon"), and General Sikorski, in a speech at the ceremony, recalled that seventeen years ago, when he was first Prime Minister of Poland, he introduced the first programme of naval construction, which provided eventually for twelve submarines, and that in 1923 he had laid the foundation stone of the Polish port of Gdynia, the development of which coincided with the evolution of the Poles into a really sea-minded nation. He expressed satisfaction that Polish ships should be fighting side by side with the British Navy, since it gave them unrivalled opportunities of gaining experience. Sir Max Horton paid a tribute to the exploits of the "Orzel," which could not have been brought out of the Baltic except by seamanship of a high order. It was the "Orzel," too, which struck the first blow against the enemy in his invasion of neutral Norway, by sinking a transport full of troops in the Skagerrak on April 8th, 1940. Another vessel under construction for the Allied Fleets is H.M.A.S. "Arunta," the first of three "Tribal" class destroyers which are being built in Australia for the Australian Navy. She was launched recently from the Cockatoo Yard at Sydney.

Fire-Bomb Fighting

ON January 18th the Minister of Home Security gave details of the Government's new compulsory scheme for fire-bomb fighting. Three new Defence Regulations have been made under which the Minister is given power to impose compulsory part-time service in all branches of the Civil Defence Force for men and women between the ages of sixteen and sixty. For the time being the new powers will be used only in connection with the prevention of fires from fire bombs and compulsion will be applied to men only. The compulsory service required is not to exceed forty-eight hours per month. Compulsion will apply in all areas in which the risk of fire raids is sufficiently great to require it. All occupiers of industrial and commercial premises in areas to which the order applies are required to make satisfactory arrangements for fire prevention and to ensure that enough people are available, each with his allotted task. There will be a general obligation upon all grades, including management, to take their turn of duty in fire-bomb fighting outside their normal working hours. For this service they will not be entitled to remuneration. If, however, proper and adequate arrangements can be made on a voluntary basis, paid or unpaid, the general obligation need not be enforced. If satisfactory arrangements are not made by the occupier the appropriate authority is empowered to step in and make them, charging any expenses involved to the occupier. Compulsory service at the place of work is to take precedence over compulsory service at the place of residence, but those already doing forty-eight hours' civil defence service a month in their residential area are not liable to be called upon for duty at their place of work. In addition to such civil defence workers, members of the Army, Home Guard or Police will not be subjected to compulsion. In the case of small factories, shops, &c., the local authority can require them to combine to provide a fire-bomb fighting service if their numbers are too small for each of them to have an independent organisation.

Historic Engines for Scrap

Two steam pumping engines made by Boulton and Watt in the early days of last century for Deptford pumping station are being handed over by the Metropolitan Water Board for the scrap iron campaign. Watt patented a rotative beam pumping engine in 1782, and in the following year supplied one to the New River Head, fitted with the sun and planet motion, and two to the East London Waterworks at Old Ford in 1807. Pickard's patent for the crank had expired by then and Watt had adopted the crank and connecting-rod. These two were broken up about forty years ago. The two now being scrapped were put to work at Deptford, one in 1812 and the other in 1824. They have not done any pumping since 1925. They were at first worked in conjunction with the water-driven pumping machinery, or "forcers," introduced by Smeaton, which remained in use until 1843, when the works were remodelled by John Rennie. Steam was originally supplied by three wagon boilers, which were replaced in 1860 by three Cornish boilers. The pressure was at first 2–3 lb. per square inch, but was raised after subsequent alterations and the installation of new boilers to 18 lb. During the century of the engines' work very few repairs and renewals were required except in the pump valves.

A New German Bomber

WITH the object presumably of counteracting the impression made by the recent announcement in this country concerning the new Short "Stirling" four-engined long-range bomber, the German official organ *Völkischer Beobachter* has disclosed the fact that the four-engine Focke-Wulf "Kurier" heavy bomber is now being used in operations against British shipping in the Atlantic. The "Kurier," it is stated, has been developed from the same maker's "Condor," a somewhat slow machine, which, strongly protected by fighters, was at one time used for daylight raids against this country, and which may still be in use for night attacks. The "Kurier" is claimed to have a high speed and to be capable of carrying an "enormous" load of bombs over long distances. It carries a crew of six, and is fitted with a de-icing device which enables it to operate in any weather. Its armament is stated to include several cannon. The Focke-Wulf works are situated at Bremen and at Johannisthal near Berlin, and have been the objects of attack by the R.A.F. The "Condor" in its original form was a four-engined commercial monoplane, adapted to carry twenty-six passengers. The engines were air cooled and were of 720 H.P. each. The maximum speed at sea level was 233 m.p.h. The normal range was 775 miles, but with increased fuel capacity and reduced pay load it could be made to reach 995 miles.

Britain's Need for Ships

SPEAKING to American Press men on January 18th, Sir Arthur Salter, Parliamentary Secretary to the Ministry of Shipping, said that in 1918 America, under a policy adopted only the year before, had launched over 3,000,000 gross tons of shipping. That was fifteen times as much as she had been building a few years before, and more than all the British shipping sunk by the enemy in the sixteen months of the present war. America was becoming an arsenal, which, with our own resources, would enable us to outmatch the enemy. It would be a tragedy for both our countries if that aid with the instruments of war was either reduced or delayed by any lack of shipping to carry them. We wanted to be sure that, not only this year, but next year and, if need be, longer, we could bring in all the munitions, aeroplanes, raw materials—as well as our essential foods—as fast as they were ready for shipment. Our need for ships was not to be measured by any net reduction in our tonnage. Up to date our losses had been nearly balanced by new building, transfer, and capture. We still had more than 97 per cent. of the total sea-going tonnage under the British flag in 1939. A reduction of less than 3 per cent. would in itself, of course, not be serious. We had cut down on the civilian peace consumption of imported goods by about ten times that percentage. But our losses had increased since the enemy had been able to use the French ports as bases for attack. Till June, 1940, the average weekly toll exacted by the enemy (allied and neutral included) was 41,000 tons. Since then it had averaged 90,000 tons and our opportunities of replacement were in some respects, for example, by capture, less than before. We were, he continued, building, buying and chartering all we could, and were making every effort to give the utmost protection to our shipping—and the American destroyers and increased aircraft would, of course, both help—but the enemy, too, was active. The net result was that if we have a prospect of adequate replacement some time ahead and could get assistance in bridging the interval, we could be confident about the future. It was certainly encouraging in those circumstances to reflect on America's potential resources. To take the two things on which shipbuilding depended, steel and applied engineering skill, America was incomparably the world's largest producer of steel (she produced in 1937 more than thirty times as much steel as all the enemy had sunk in this war) and she had the largest resources of readily adaptable engineering labour.

Wage Claims Award

ON Tuesday of this week, January 21st, the National Arbitration Tribunal issued its findings on the claims for increased wages advanced by the unions covering the engineering and shipbuilding industries. It may be recalled that the Amalgamated Engineering Union and the National Union of Foundry Workers sought an increase of 12s. per week and the Confederation of Shipbuilding and Engineering Unions an increase of 10s., with an equivalent increase for piece workers. The Tribunal's award on both claims is that the existing national bonus is to be increased by 3s. 6d. a week in the case of all adult male workers. The award is to take effect as from the beginning of the first full pay period following January 20th. The claim of the Amalgamated Engineering Union for the full restoration of the working conditions existing before June, 1931, is rejected. It is estimated that the award will benefit more than 1,000,000 workers in the engineering industry and 200,000 in the shipbuilding and ship-repairing industries, and that it will cost those industries about £9,000,000 a year.

The Strength of British Aircraft

DURING the war of 1914–18 it was considered to be a good rule that the pilots of our aircraft should know no more about the construction of their machines than was sufficient to enable them to learn to fly. Doubtlessly the rule was a good one in those days, when neither the materials of which aircraft were constructed nor the manner in which they were employed were such as to inspire great confidence in the strength of the machines. We can recall on one occasion just before taking off in a heavy bomber examining the manner in which the wings were attached to the fuselage, and being somewhat startled to find that our safety was about to depend on four steel pins no thicker than a lead pencil. Nothing perhaps could bear more eloquent testimony to the improvement which has since been made in aircraft construction than the fact that it is now the settled policy of the Air Ministry to encourage our pilots and airmen to visit the aircraft works and to see for themselves the manner in which the machines they fly are constructed. Such visits can only increase the already high confidence which the air crews have from hard experience come to repose in their aircraft. Many reports have been received concerning British machines returning safely to their bases in a condition which would almost seem to render flight impossible. Nor is it simply a matter of a damaged aircraft just managing to creep home. Occasionally machines are hit while carrying out an attack and sustain hurt which a few years ago would have proved almost instantly fatal. Nevertheless, they are not deflected from their target, and press home the attack before returning home. A recent instance occurred during an attack on Brest. A Hampden bomber, diving through low clouds, came down to 2500ft. to attack the target. It was caught in the beams of three searchlights and was attacked by an enemy fighter. The British pilot evaded the fighter, but in doing so lost another thousand feet of height and encountered a heavy barrage. The aircraft was hit by a shell. Nevertheless, it made two runs over the target, dropping bombs on the dry dock and extinguishing a searchlight by machine gun fire. On returning home it was found that the leading edge of the tail plane had been struck and torn. It is good to learn, as we do from an official source, that the instruments with which our aircraft are fitted are as carefully made and are as trusty as the machines.

Hydrogenation and War

By A. E. WILLIAMS, F.C.S.

IN these days of food rationing our intake of hydrogen, through the increased consumption of hydrogenated fats, is considerably greater than in peace time. Let us assume that there are 40 million human mouths in this country, each one of which takes only 4 oz. of margarine or cooking fats per week. To create a year's supply for each mouth requires, on an average, 4 cubic feet of hydrogen, or 160 million cubic feet of hydrogen per year to feed the population. In peace time, when butter and other natural fats are available in plenty, only about one-half of this amount of hydrogenated fats is consumed in this country. Accordingly, in war time we have to find an extra 80 million cubic feet of hydrogen each year for food purposes alone. In addition, large volumes of hydrogen are directed towards increasing the supply of motor fuels by the hydrogenation of coal and coal tar. Briefly, hydrogenation helps us, particularly in war time, by supplying us with food, motor fuels, and chemicals which in normal times we should import.

WHALE OIL

Shortly before the present war began the British Government, with commendable foresight, gathered together several hundred thousand tons of whale oil and stored it at suitable points in the country as a food reserve. This fact shows the importance now attached to whale oil as a food. Without hydrogenation processes, however, whale oil would not be of much use in these modern times, although before the coming of coal gas, early in the nineteenth century, it formed the principal illuminating oil of this, and other, countries. A little later even the country districts, where gas companies were unknown, ceased to use whale oil as an illuminant, but preferred the new material—paraffin oil—which had just become available. Thus it happened that the whale oil industry, which was in a very flourishing condition in the year 1800, was practically non-existent in 1900. Its revival to its present huge scale is due entirely to the discovery of hydrogenation principles, by the technician Sabatier, in the closing years of the nineteenth century. His work is described in the French book "La Catalyse en Chimie Organique." Within a few years British technical men became interested in Sabatier's ideas and developed them so that they could be applied to the hydrogenation of oils. The first industrial plant for this purpose was erected at the soap works of Joseph Crosfield and Sons, Warrington.

HARDENED WHALE OIL

From the soap manufacturer's point of view hydrogenated, or hardened, whale oil is more suitable than raw whale oil, for the latter cannot be used to any large extent in soap owing to its pronounced odour. Hydrogenation, however, rids the oil permanently of its characteristic odour, and also yields a harder and more valuable soap.

During the war of 1914–1918 hardened whale oil was introduced as a food, in margarine and other fat mixtures, wherein it takes the place of stearin, tallow, &c. The many fears and objections to its use as human food which were voiced in the early days are now known to be entirely groundless. The food value of modern margarine is commonly asserted to be at least equivalent to that of butter. Nevertheless, prejudice dies hard, and many people are still old fashioned enough to prefer a pound of butter from a very unscientific farm to a pound of margarine from the latest modern factory. Other outlets for hardened whale oil include its use in the manufacture of lubricants, in which it confers "body" on the thin mineral oils. For example, Rolfsen (B.P. 258,606) adds up to 10 per cent. of hardened whale oil to a mineral oil in producing a lubricant for use in internal combustion engines. The leather industry uses the hardened oil in the stuffing of leather (Lumbard, *Jour.*, Amer. Leather Chem., 1915, 80), while in the pharmaceutical trades it forms the basis of many ointments, plasters, &c.

Whale oil is the oil mostly used for hydrogenation, but any of the fatty oils lend themselves readily to hardening; the deciding factor is an economic one. The hardened oil obviously costs more than the unhardened oil, and there must be some useful outlet for the hardened product to make it stand the costs of hardening. Peanut oil is hardened for use in an "entirely vegetable" cooking fat. Hardened coconut oil replaces, partly or wholly, the more expensive cacao butter in chocolates. A lubricating grease for motor car gear-boxes is made, according to Fox (*Jour.*, Soc. Chem. Indus., 1918, 304), by mixing 14 per cent. of a mineral oil with 86 per cent. of hydrogenated soya bean oil.

HYDROGENATION OF FATTY OILS

A fatty oil consists of glycerine in chemical combination with various fatty acids, and in most oils some of these acids are of the unsaturated variety—that is, they are capable of combining with hydrogen to form an acid with a higher melting point. Thus olein, a liquid compound of oleic acid and glycerine, can be converted to stearin, a solid combination of stearic acid and glycerine, by adding 6 atoms of hydrogen. This reaction is represented by the following equation:—

$$\underset{\text{Olein}}{(C_{17}H_{33}\,.\,CO\,.\,O)_3C_3H_5} + \underset{\text{Hydrogen}}{3H_2} = \underset{\text{Stearin}}{(C_{17}H_{35}\,.\,CO\,.\,O)_3C_3H_5}$$

Unfortunately, this added hydrogen cannot be made to combine with the unsaturated acids by merely blowing a stream of the gas into the oil. A catalyst is necessary—usually nickel in some form or other—and heat and pressure are also required to make the process practicable. A nickel catalyst may be initially in the form of either carbonate or formate of nickel. When the carbonate is employed it is first reduced in a current of hydrogen at a temperature of about 270 deg. Cent., and is then used directly in the oil to be hardened or, if stored, is covered with dry oil to prevent oxidation. Nickel formate is generally more convenient to use than the carbonate, for the formate can be reduced to metallic nickel by heating directly in the oil to be hardened; thus reduction of the catalyst and hydrogenation proceed simultaneously. Plants using either of these nickel compound catalysts operate on the batch system, but a continuous system of hydrogenation has been in existence for some years. This continuous process involves the use of metallic nickel itself, in the form of turnings contained in a perforated container. The surface of the nickel turnings is reactivated at intervals by electrolytic oxidation—the electrolyte being usually sodium carbonate solution—followed by reduction in a current of hydrogen, when it is ready for use once more. This continuous process, which has been developed in Great Britain mainly by Technical Research Works, Ltd., has several advantages over the batch method of operation. These are:—(1) Continuous operation; (2) hardened oil requires no filtering, since no powder catalyst is employed; (3) economy in nickel, since it can be re-used almost indefinitely; (4) no "splitting" of the oil during hydrogenation, giving rise to free fatty acids; thus the neutralisation of the oil after hardening, with its accompanying losses, is not necessary.

EFFICIENCY FACTORS

The efficiency of the hydrogenation process—particularly with the batch system in which powder catalysts are used—depends upon a number of factors, such as the pressure of the gas, the temperature of the oil, and the degree of mixing of the oil, gas and catalyst. This necessary intimate mixing is accomplished either by an arrangement of stirrers in the hardening autoclave, in which the three materials are churned up together, or by spraying the oil and catalyst mixture in a finely divided state (atomisation) into an atmosphere of hydrogen.

During hydrogenation two important changes occur in the oil; the melting point rises and the iodine number falls. The iodine number is ascertained by a chemical test and serves to distinguish one oil from another, since each unhardened oil has a characteristic iodine number, the higher this number the more unsaturated being the oil. As the oil takes up hydrogen this number progressively falls and its value at any specific stage of the hydrogenation process indicates approximately the melting point achieved. Theoretically it requires 34 cubic feet of hydrogen per ton of oil per unit drop in the iodine number and in the following table the original iodine numbers of some typical oils are given, together with the values of the iodine number after hardening, the melting points of the hardened oil and the gas consumed by the oil.

Unhardened oil.	Initial iodine number.	Hardened oil.		Hydrogen consumed, cubic feet per ton of oil.
		Iodine number.	Melting point, deg. Cent.	
Whale	120	20	51	3400
Whale	120	60	41	2040
Coconut	9	1	40	272
Soya bean ...	130	50	48	2720
Cottonseed ...	112	50	50	2108
Linseed	180	49	48	4454
Peanut	90	50	49	1360

The oil is generally hardened to the degree most suitable for the purpose it has to serve. For example, coconut oil, with a melting point of 22 deg. Cent., is too soft to simulate cacao butter (M.P. 32 deg.) in chocolate, and it is usual to harden it to nearly the full amount possible so as to get a harder fat than cacao butter. As a consequence a lower proportion of coconut oil serves to keep the chocolate firm in hot weather. In margarine or baking fats the proportion of hardened whale oil (M.P. about 51 deg. Cent.) may be from 20 to 30 per cent., the balance being other, unhardened, edible oils. Fatty oils for lubricants are hardened in accordance with whether a grease or a liquid lubricant is required. The latter can never contain a high proportion of hydrogenated drying oil, because drying oils are very unsaturated, as can be seen from their original iodine numbers in the table, and these high figures must be brought well down before the drying properties are destroyed. Accordingly, it would not do slightly to hydrogenate linseed oil, for example, and use it in admixture with a mineral oil as a lubricant. The main use of drying oils as lubricants is as a substitute for petroleum jelly, and they are said to last much longer in use than a lubricant with a petroleum jelly basis.

The progress of the hydrogenation of a fatty oil is accelerated by increasing the pressure. This fact was established by Moore, Richter and Van Arsdel (*Jour.*, Indus. Eng. Chem, 1917, 451). Fig. 1

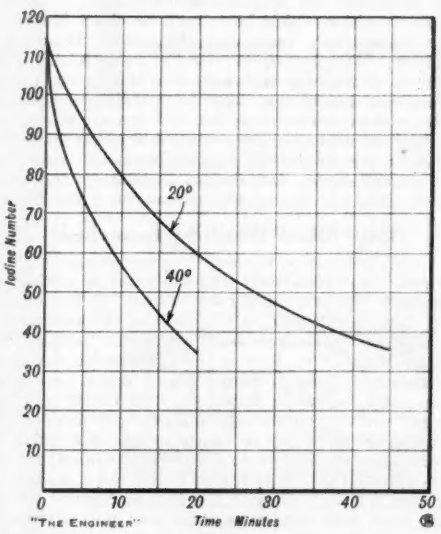

FIG. 1

shows that the time taken to lower the iodine number to a given figure, 35 in this case, is more than twice as long at a pressure of 20 lb. per square inch than it is at 40 lb. per square inch. In other words, hydrogenation progresses at a rate roughly proportional to the gas pressure. Increase of temperature also accelerates the rate of hydrogenation, but as most fatty oils are damaged if heated to much over 220 deg. Cent., there is a limit to the temperature that can be applied in practice. The curves in Fig. 2 show the effect of various temperatures. A positive temperature coefficient exists within the range of 35 deg. Cent. and about 200 deg. Cent., but, as the curves show, this coefficient decreases with increase in temperature. For example, within the range of 35 deg. Cent. and 125 deg. Cent. the time taken in lowering the iodine number to a specific value is decreased by about 35 per cent. with every 10 deg. temperature increase; but between 160 deg. Cent. and 200 deg. Cent. the coefficient is under 20 per cent. In practice, however, especially with "sensitive" oils, it is not advisable to work at a temperature higher than about 160 deg. Cent., so that full advantage cannot be taken of speeding up the process by working at what would otherwise be the

optimum temperature. In any case, as the curves show, process time is not greatly curtailed by working at 200 deg. Cent., for example, instead of at 160 deg. Cent. The proportion of catalyst in the oil also affects the rate of hydrogenation, this rate being increased in proportion to the increase in catalyst concentration, but because of the relatively high cost of nickel not more than about 1 per cent. of the weight of the oil is normally used; and when working by the batch process, with a powder catalyst a high proportion of nickel

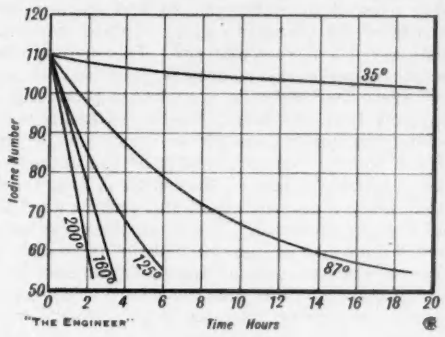

FIG. 2

to oil would entail extensive filter press equipment to separate the nickel from the hardened oil.

WATER GAS

At one time water gas was used principally to dilute the more costly coal gas, making the latter less efficient in illuminating and heating power. However, within the last few years water gas has widened its functions, for many hydrogenation processes use it as a basis from which to build up, synthetically, a great variety of other substances. Theoretically, water gas should consist of carbon monoxide and hydrogen only, obtained by blowing a current of steam over red hot coke or other form of carbon, when the following reaction occurs :—

$$\underset{\text{coke}}{C} + \underset{\text{steam}}{H_2O} = \underset{\text{carbon monoxide}}{CO} + \underset{\text{hydrogen}}{H_2}$$

This reaction is endothermic and therefore the coke must be kept at a high temperature, otherwise carbon dioxide and hydrogen are formed. In practice most water gas plants make use of alternate currents of air and steam. The greatly increased demand for water gas in synthetic processes has led to numerous improvements in the erstwhile crude methods of its production, most of which are protected by patents. Gordon (B.P. 282,141) describes a typical method in which finely divided fuel is passed with steam through an externally heated vessel constructed of an alloy steel containing a large proportion of chromium or similar metal. The fuel is passed through the tubes, which are heated by a low-grade coal in a similar manner to that of a pulverised fuel boiler furnace. The furnace gases pass over the tubes with high velocity to ensure good heat transfer. In an example finely divided coke and steam are blown through a "Staybrite" tube, 30ft. long by ½in. diameter, at about 30ft. per second, the tube being heated to around 1000 deg. Cent. In this way a high-grade water gas is obtained with only about 1 per cent. of carbon dioxide. The object of using stainless steel equipment is to keep the gas free from the contaminating influences of ordinary steel. Such impurities as sulphur and volatile iron compounds in the gas act as catalyst "poisons" in the subsequent synthetic processes in which the gas is employed. Other methods of water gas production use ordinary steel and get rid of impurities by "scrubbing" the gas with various chemicals.

HYDROGENATION OF WATER GAS

The hydrogenation of water gas may also be regarded as the reduction—by hydrogen, in certain circumstances—of its carbon monoxide to carbon. By depriving it of its oxygen in this way we get a hydro-carbon. For example, if the hydrogen proportion in the water gas is increased and this gas mixture is passed over a nickel catalyst at a temperature of about 240 deg. Cent., a mixture of methane, CH_4, and water vapour is obtained. Methane is a hydro-carbon gas given off both by coal and petroleum, and its synthesis in this way, by means of hydrogen, is significant in that it points the way to the formation of the more valuable—liquid—members of the hydro-carbon group; in short, the motor fuels we need. By using appropriate catalysts, temperatures, and pressures, substances other than hydro-carbons can be obtained, and these are generally referred to as oxygenated compounds, for, unlike the hydro-carbons, they contain oxygen. These oxygenated compounds, which can be synthesised from water gas, include various alcohols, and also fatty acids such as occur in natural fatty oils. Since a natural fat consists mainly of fatty acids in combination with glycerine it will readily be seen that synthetic food fats can be made by the hydrogenation of water gas, if only glycerine, or a substitute, is available. Briefly, the two types of "oils" made by hydrogenating water gas consist either of a mixture of hydro-carbons, or of a more complex mixture, the oxygenated compounds, of which latter wood alcohol is a simple and typical example.

WOOD ALCOHOL

Wood alcohol, or methyl alcohol, is produced principally from wood; but the latter is now a scarce commodity in this country, so that the making of wood alcohol by hydrogenating water gas receives considerable impetus in war time. It first became available through hydrogenation in 1923 and its manufacture in this synthetic manner caused much consternation among those who made it from wood, who feared the entire loss of their business. The Governments of some countries, however, have assisted them by stipulating that as a denaturant for ethyl alcohol only methyl alcohol from wood may be employed.

Wood alcohol, with the composition of $CH_3 . OH$, may be regarded from the point of view of synthesis as an intermediate product between the simple hydro-carbon methane and the more complex "oils" which are produced from water gas. It is made in much the same way as methane, and the various protected methods covering its manufacture appear to differ mainly in the type of catalyst used. Thus, Dreyfus (B.P. 262,494) passes a mixture of hydrogen and water gas over a zinc oxide catalyst, at a temperature between 200 deg. and 450 deg. Cent., and under a pressure of 50 to 150 atmospheres, contained in a vessel copper-lined or of aluminium. In general, the different catalysts advocated in different patents may be classified as (1) metallic oxides, (2) alloy metals and simple metal mixtures, and (3) mixtures of (1) and (2). To obtain a high proportion of wood alcohol efficient control of temperature and pressure with any specific catalyst is necessary. Appreciable heat is generated in the reactions of hydrogen with the oxides of carbon, and Johnson (B.P. 279,347) makes use of this free heat for steam raising. In a steam boiler there is arranged a series of tubes with a catalyst inside them. Through the tubes a mixture of carbon monoxide and hydrogen is passed and the heat generated is sufficient to maintain a steam pressure in the boiler of about 17 atmospheres, giving a temperature about 205 deg. Cent. An alternative method of obtaining a suitable mixture of gases as the starting point for these synthetic products has been developed by the Lurgi Company in Germany (Armstrong and Williams, *Chem. and Indus.*, January 6th, 1940). In the Lurgi generator the gasification of low-temperature coke, under a pressure of 8½ kilos. per square centimetre in a stream of oxygen and steam, yields a gas mixture which, after passing through water to remove some of the carbon dioxide, has the following composition :—

	Per cent.
CO_2	1·0
CO	30·7
H_2	61·6
CH_4	4·6
N_2	2·1

Such a gas mixture consists of 92 per cent. of the gases in the correct proportions which are of direct use in synthesising oils, &c.

SYNTHETIC OILS

The term "oil" is always both vague and indefinite, and when we add "synthetic" we do not clarify it, but, on the contrary, give it a wider meaning. For example, synthetic wood alcohol is classed as an "oil," although its properties and composition are identical with natural wood alcohol. The various alcohols produced by hydrogenation are termed oils because they mostly go to replace the true mineral oils as motor fuel. Prominent among the workers in the sphere of synthetic oils are Fischer and Tropsch, and in 1926 they perfected a method for producing the oils by using only atmospheric pressure, which, naturally, made the plant used less complicated and expensive. A description of their work appears in the German volume "Die Umwandlung der Kohle in Ole." A typical crude synthetic oil made by the Fischer and Tropsch process consists of 20 per cent. fatty acids, 40 per cent. alcohols, and 40 per cent. hydrocarbons. Such a heterogeneous mixture is by no means desirable commercially, because it has to be repeatedly distilled to obtain the most useful fractions. This fact has led to much experimenting to find a way to get the maximum proportion of one desired product and thus cut out the distilling costs. These efforts have culminated in many patented processes. For example, Fischer and Tropsch (B.P. 255,818) mix water gas with hydrogen, pass the mixture over a catalyst of zinc oxide and finely divided iron, at atmospheric pressure, and at a temperature of about 300 deg. Cent. The resulting hydrocarbons consist of 10 per cent. methane and 90 per cent. of higher hydrocarbons. The I.G. Farbenindustrie A.G. (B.P. 317,808), in producing alcohols, fatty acids and hydrocarbon oils from water gas and hydrogen, avoids the formation of both carbon and methane by using catalysts of copper, silver, gold, &c., intermixed with iron, cobalt or nickel. There are scores of similar protected processes on record, mostly claiming that a specific catalyst, in conjunction with a certain temperature and pressure, will give the desired results. But so far as can be gleaned from published information, the production of synthetic methyl alcohol has reached the highest stage of efficiency and it can be produced in a higher proportion than any other synthetic "oil." Most of these oils, when synthesised, are mixtures and have to be distilled; and in the majority of cases, like petroleum, we get a solid residue remaining in the still, which residue varies in consistency from vaseline to paraffin wax, according to the distillation temperature used. The following table (*Nat. Petrol. News*, October 20th, 1926) gives some characteristics of a typical hydrocarbon mixture of oils obtained by hydrogenation of water gas :—

Fraction.	Boiling range, deg. Cent.	Weight, per cent.	Specific gravity at 20 deg. Cent.	Carbon, per cent.	Hydrogen, per cent.
1	20– 55	26·6	0·6367	81·23	15·60
2	55– 75	27·9	0·6488	84·48	15·46
3	75–120	28·1	0·6838	85·04	14·98
4	120–180	12·0	0·7264	83·35	14·96

Such fractions are, in general, of a faint yellow colour, not darkening or depositing gummy matter on storing. The calorific value of these synthetic fuels ranges from about 10,000 to 11,500 calories per gramme. If the crude synthetic oil is cracked in an autoclave at a temperature of 400 deg. Cent. some loss occurs owing to the formation of water and gases, but the balance is a petroleum-like liquid (Fischer, *Ind. Eng. Chem.*, 1925, 17,574). Synthetic "benzol" has been tried in a 4 H.P. motor-cycle engine by Davin (*Chem. Abs.*, 1925, 19, 3155), the engine being adjusted for running on benzol, 100 c.c. of the latter giving 2·9 kiloms., against 3·0 kiloms. for synthetic oil. When the synthetic product was mixed in equal proportions with benzol 3·2 kiloms. per 100 c.c. was obtained.

Much secrecy is preserved regarding details of construction of synthetic oil plants; but, in general, the autoclaves used must have high tensile strength and be resistant to the gases, catalyst vapours and relatively high temperatures. Ordinary mild steel construction is therefore ruled out. Alloy steels are employed, the non-ferrous constituent used being generally nickel or chromium.

Before the R.A.F. began to attack German hydrogenation plants the enemy's output of oils was much greater than that of this country. The production of oils by the hydrogenation of coal and tar, as also by the hydrogenation of water gas (synthetic oils), was carried out on a large scale at the I.G. Farbenindustrie works at Leuna and Mannheim. Similar plants of the Badische Company were at Merseburg, and others of the Gesell. für Teer Verwertung were in the Ruhr district. When the present war began it was estimated by competent authorities in this country that Germany's hydrogenation plants were turning out three million tons of oil per year, or roughly 10 per cent. of the country's total oil requirements in war time. This figure is exclusive of synthetic wood alcohol, which is also used as a fuel in Germany. However, these three million tons do not all go to feed mechanical engines; the human engine takes its share of fuel out of this quantity.

BUTTER FROM COAL

The Germans were the first to develop coal as a source of human food. Even before the

present war began they made both butter and soap from coal as a fundamental material. In this country there is no incentive for us to adopt the same measures because we have access to sufficient supplies of natural fats, and these make better soap and butter than can be obtained synthetically. At the same time, to technical men, the efforts of German engineers and chemists to furnish their country with a substitute for the fats we are forced to deprive them of must be regarded as laudable. According to a lecture by Dr. Wietzel before the Verein deutscher Chemiker (Society of German Chemists) and reported by E. Lemaine (*La Genie Civil*, CXV, 413), coke is first produced from the coal, followed by water gas from the coke. To the water gas a proportion of hydrogen is added to give the correct mixture for subjection to the Fischer-Tropsch process. The impure fatty acids separated from the mixed "oils" of this process are next purified by chemical methods and by distillation. These fatty acids represent from the chemical point of view one of the main components of a natural fat, and only glycerine or a similar alcohol is required to give an imitation of the natural products. The chemical combination of glycerine with fatty acids to make a synthetic fat is a well-known process, and has been carried out in this country in an experimental way. But as the source of glycerine is the natural fats themselves it is unlikely that Germany is using her sparse supplies of glycerine from fats to make synthetic butter. On the contrary, she is more likely using it mainly for war purposes.

Dr. Wietzel does not tell us how he gets butter with his fatty acids from coal, but we may safely assume that he has a substitute for the glycerine from fats, possibly one of the synthetic alcohols produced from water gas. During the war of 1914-1918 the Germans evolved a method whereby glycerine can be made from glucose, a derivative of starch of which Germany obtains an abundance from her potato crop. Their novel way of creating glycerine from glucose comprises fermenting, with ordinary brewer's yeast, a mixture of glucose and sodium sulphite, the latter being partly converted to sodium carbonate by taking up the carbon dioxide from the fermentation. After fermenting, the carbonate and sulphite are removed by adding lime and calcium chloride before filtering the weak liquor. This is next distilled in a fractionating column, which recovers the alcohol produced during fermentation. There is a considerable proportion of residue after removal of the alcohol and this residue represents weak glycerine, which is then concentrated and further distilled to produce pure glycerine. The yield of concentrated glycerine from this process is about 25 per cent. of the weight of the original glucose, in addition to which a similar quantity of alcohol is produced, besides lesser proportions of other useful chemicals. Thus it is possible that in the course of time Germany could make herself independent of outside supplies of fats, since she can get the necessary fatty acids from her coal—and possibly also a glycerine equivalent—and the glycerine from her potato crop. By combining fatty acids and glycerine in various proportions, adding coal tar dyes and flavouring, it is possible to imitate a wide range of natural oils and fats.

Another innovation by the Germans in this direction is outlined by Smaltz (*Koll. Zeit.*, 1935, 71), who states that synthetic fats can be produced by combining fatty acids with alcohols other than glycerine, such as glycol, &c. These alternative alcohols can readily be made in Germany from her own basic materials, but as fats made with glycol would be of a toxic nature it is reasonable to assume that these fats are used exclusively for non-edible purposes, such as in soaps and textile preparations.

HYDROGEN PRODUCTION

In this era of hydrogenation the making of the necessary hydrogen has, naturally, received much attention. There are now nearly one hundred known methods of producing the gas, but only four of them are in large commercial usage in European countries. These four may be classified as (1) electrolytic, (2) liquefaction, (3) catalytic, (4) steam-iron processes. In the U.S.A. and in other countries wherein natural hydrocarbons can be obtained cheaply, hydrogen is also produced by (*a*) catalytic methods from methane gas, and (*b*) by converting hydrocarbons, at high temperatures, to their elements hydrogen and carbon, the latter being deposited as a solid. Since natural hydrocarbons are not available cheaply in this country they are of no direct interest to British manufacturers of hydrogen.

The hydrogen used for hardening fatty oils has to be of a high standard of purity; that is, well over 99 per cent. hydrogen, and must contain no sulphur or other deleterious matter to "poison" the catalyst. A gas of this purity is given direct by the electrolysis of water, and because little or no further purification of the gas is necessary the electrolytic method is often as economical as other processes. Especially is this the case when cheap electricity is available and the oxygen, simultaneously formed, can be disposed of advantageously. Electrolytic methods have been developed in this country chiefly by Knowles, the electrolyte used being generally caustic soda solution. The liquefaction process consists of liquefying the carbon monoxide in water gas, so freeing the hydrogen and the small proportion of other gases. These latter gases are, however, difficult to get rid of and prevent the hydrogen so produced being used for oil hardening, although it is quite suitable for some other hydrogenation processes. Separation of the monoxide from the hydrogen may take place in a Linde liquefaction plant or similar equipment. Water gas is also used as a raw material in the catalytic process. In this a mixture of water gas and steam is passed over a catalyst, such as iron oxide and a chromium compound, at a specific temperature, the resulting gases being chiefly a mixture of hydrogen and carbon dioxide. This latter gas is more easily separated from a mixture than is the monoxide, for it can be removed easily by chemical means, such as absorption by lime solutions. The catalytic process is the youngest of the commercial methods of hydrogen manufacture and it has made more headway in Germany than in our country. It is the subject of numerous patents, concerned mainly with the type of catalyst employed to obtain the purest gas. In the steam-iron process water gas is first passed over iron oxide, which reduces the latter to iron. When a current of steam is passed over the hot iron the latter takes up the oxygen from the steam, allowing the hydrogen to pass. The oxidised iron is then again reduced by water gas, so that the process consists of the alternate passing of water gas and steam over the ferrous material. This method has been developed in this country by Lane and others.

Of these four methods of hydrogen production, the electrolytic process has the basic advantage of yielding the purest gases direct, for in the electrolysis of water, even although it be contaminated with catalyst "poisons" like sulphur, &c., these impurities are not volatilised and sent forward to foul the gas produced. The other three methods depend upon coal or iron ore, and the impurities in these minerals are gasified and so contaminate the gas. Moreover, in war time the electrolytic process is most in demand because it produces, simultaneously, two pure gases of great military importance. These gases may be collected in cylinders at one and the same depôt. The Service Departments use oxygen and hydrogen for field service welding, oxygen for the hospitals and air crews, and hydrogen for the barrage balloons.

Electrical Engineering in 1940

No. IV

(*Continued from page 51, January 17th*)

Furnaces

THE General Electric Company, Ltd., reports that there was a continued increase in the number and type of electric resistance furnaces installed. There was an increase in size of unit. Some of the roller hearth type are in operation, having a length of 200ft., and are used generally for the bright annealing of cold-rolled steel strip in straight lengths, boiler and other tubes (inside and outside), and non-ferrous metals and alloys in sheet and strip.

Much development work was undertaken in connection with the production of artificial gas atmospheres required for the bright annealing of medium and high-carbon steels which have been rolled or drawn with different lubricants, for the hardening of steel parts without scaling or decarburisation; for the clean hardening of high-speed tool steels; for brazing furnaces, &c. A new electrode type salt bath furnace for the hardening of high-speed steel tools was introduced. It is also being used very successfully for brazing high-speed steel and tungsten carbide tips on to medium-carbon steel shanks. Heat is generated by the passage of the current through fused salts, which are so compounded as to be neutral. The normal working temperature range is from 1100 deg. to 1350 deg. Cent. Since all the faces of the work when immersed are in contact with the molten salt, the rate of heating is high, and so is the output of the furnace. Even with small cutters the finish and hardness of the fine edges are unimpaired by heat treatment in a salt bath furnace.

Hitherto induction furnace selector switching has been carried out by means of orthodox knife switches, modified slightly on account of frequency, housed in cubicles situated upon the furnace platform and arranged for hand operation. These switches were designed to carry 800 amperes per blade and comprised anything from four to twelve blades. This arrangement resulted in increased lengths of bus-bars, together with not inconsiderable erection difficulties, whilst it was also found difficult to retain the interleaving of the bars which the high frequency demands. A new bus-bar selector switch was therefore developed by the Metrovick Company to overcome these difficulties. The new switch is of skeleton design and so arranged that only one dimension, the length, varies according to the number of blades it carries. The knife blades carry 800 amperes each and move through only 60 deg. to effect

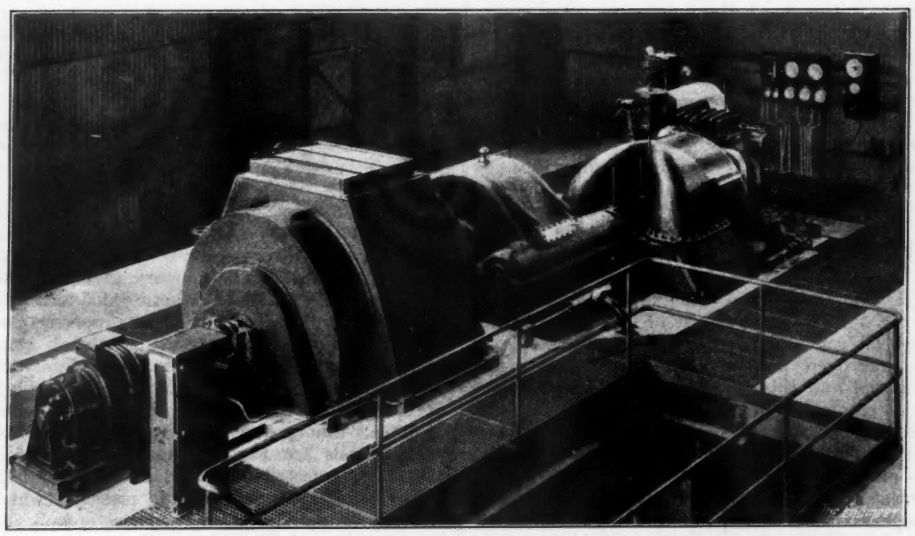

FIG. 16—4000-KW TURBO-ALTERNATOR FOR SOUTH AFRICA—B.T.H.

a change from one set of bus-bars to another, and the connections disconnected become earthed automatically. An off position is provided midway. The design is such that the switch may be mounted in any position, thus enabling an economical and straight run of interleaved bus-bars to be maintained. Operation is by a fractional horse-power motor and a full set of auxiliary switches is provided to render the stopping of the motor automatic to facilitate interlocking with other apparatus and to give position indication. Control is effected from a simple switch mounted on the furnace control cubicle, or in any convenient position.

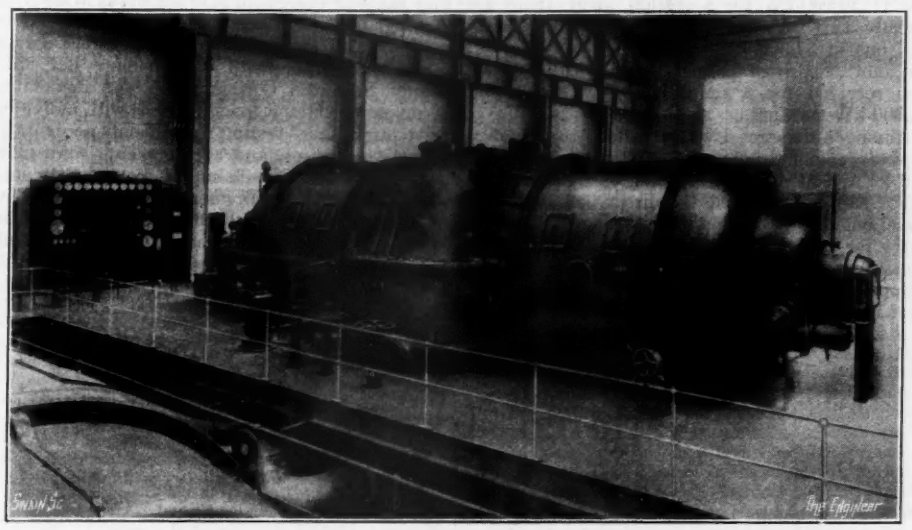

FIG. 17—37,500-KW LJUNGSTROM TURBINE FOR BRITISH POWER STATION—BRUSH

Lighting

During the year the General Electric Company, Ltd., introduced the 5ft. Osira discharge lamp. The lamp, which is in the form of a tube, is filled with mercury vapour and the inside of the tube is coated with fluorescent powder. This combination conduces to light being uniformly spread over the whole length of the lamp. The lamp is rated at 80 watts and gives a light equivalent to a 200-watt tungsten lamp. The lamp is designed for operation on A.C. mains only of 200/250 volts.

In the process of final finishing of tools and gauges, which is usually accomplished by scraping, it is difficult to detect high spots, and it has been found that the older method of coating the surface with jewellers' rouge can be replaced with increased speed and accuracy and without strain to the eyes by coating the surface with a mixture of powdered anthracene in medicinal paraffin oil and inspecting the work under the rays of an Osira black glass lamp. In these circumstances high spots fluoresce brilliantly enough to be clearly visible in a normally lighted room.

An improved method of construction has been introduced in the manufacture of high-power Osram lamps. It relates to the method of bringing heavy leads into the bulbs. The new method uses the inverted bi-post principle, which is a modification of the standard bi-post construction. The hollow copper posts are now inside instead of outside the lamp with the standard G.E.S. cap retained. The leads from the cap are fitted inside the copper posts which are joined to the two extremities of the U-shaped pinch, making gas-tight glass-to-metal joints in the usual way. The heavy channel bases bolted to the posts carry the filament system, which has also been strengthened by shortening and stiffening the supports. The complete mount is sealed into the bulb, which is exhausted and filled by the usual methods. The inverted bi-post construction is very strong mechanically, and should prove of great value in lessening the risk of damage to high-power lamps in transport and service.

A development worthy of mention is that by the Metrovick Company of a high-pressure mercury vapour discharge projector lamp, rated at 250 watts, with an efficiency of 45 L/W, and an intrinsic brilliancy at peak of 20,000 stilbs. It is particularly suitable in the field of microscopy, the examination and photographing of metal specimens, &c.

Miscellaneous

In response to the need for replacing calcium flares by an electrical lighting device, particularly on oil tankers and diesel ships where large quantities of oil might be released and float on the water, the G.E.C. designed a suitable type of apparatus to comply with the requirements of the Ministry of Shipping known as the G.E.C. "Life-Light" (Patent Application No. 32,305/39). It is suitable for use in passenger and cargo ships, drifters, trawlers, oil tankers, and minesweepers. A metal cylinder which contains the lamp, dry cells, and automatic gravity-action switch is equipped with a buoyancy chamber or float. It is so balanced that when thrown into the water the bulb is uppermost and the switch operates automatically to switch on the light. A ring is provided at the base enabling it to be suitably suspended, and in this position the switch automatically cuts off the current. Accidental illumination in this position is impossible. The containing cylinder and float are constructed of steel and the lamp bulb is protected by armour glass. The wellglass is rounded so that oil drains off, preventing the light from being obscured. A spring plunger in the bulb holder prevents the circuit from being broken, even if the bulb should slacken right back, and the bulb is prevented by the wellglass from coming right out. The life-light is fitted with a 3·5-volt, 0·3-ampere Osram bulb, and two 1½-volt cells, either the dry type or inert type. Having a continuous burning life of more than twenty-four hours, should the life-light not be used at all during the day the batteries will provide sufficient current for three nights' use of ten hours each. Unit cells which have about eight hours can also be used.

The country of Iraq is making rapid advance in its development, and the company's telephone works is engaged in manufacturing for the City of Baghdad one of the largest public automatic telephone exchanges in the Near East, which ultimately will provide for 10,400 subscribers. At the works were manufactured also the radio receivers for the new broadcasting station in Johannesburg, which receives and rebroadcasts programmes from Daventry and many towns in Europe and the British Empire.

Motors were being built for various mining companies in South Africa and West Africa; air-cooled, pumpless, steel-clad rectifiers were in course of construction for towns in India, New Zealand, and Western Australia; switchgear schemes were in hand for an industrial company in Turkey, for railways in India and South America, and also for a South African municipality. A D.C. generator to be driven by a Fraser and Chalmers oil engine is destined for electricity supply in Macao, and turbo-alternators are required for installation in South Africa and India. Undertakings in the Federated Malay States are to be provided with several large transformers and welding plant. High-voltage transformers of considerable outputs will form part of the equipment of large transmission schemes in New Zealand.

According to the B.T.H. Company the demand for industrial heating grew considerably during the year, especially in connection with extrusion presses and salt baths. The advantages of electric heating have been particularly appreciated in those cases where gas services have been interrupted. As a result of increasing experience the practice of using the torribar element with special sheath material was adopted in place of the heaters previously cast in. Other industrial heating applications include heat treatment of brass cartridge cases by the use of electrically heated lead baths, the quenching of light alloy sheets by modified water heaters in quench tanks, and the heating of creosote oil produced in gas works as a substitute fuel for petroleum to be used largely in foundries and glassworks.

During the year orders for upwards of 400 thyratron regulators for generator voltage control were received by the B.T.H. Company. While the majority of these regulators were for small machines where special requirements, such as very close regulation, are to be fulfilled, a number were supplied for use with turbo-alternators. One installation of the latter type is unusual in that four generators are controlled simultaneously from one regulator, giving a total exciter field current provided by the regulator of about 35 amperes. Complete stability and good load sharing have been obtained. During the day the regulator controls the common bus-bar voltage, and at night one of the turbo-alternators (of about 2500 kVA) is run in parallel with the grid and the regulator then maintains unity power factor at the grid intake.

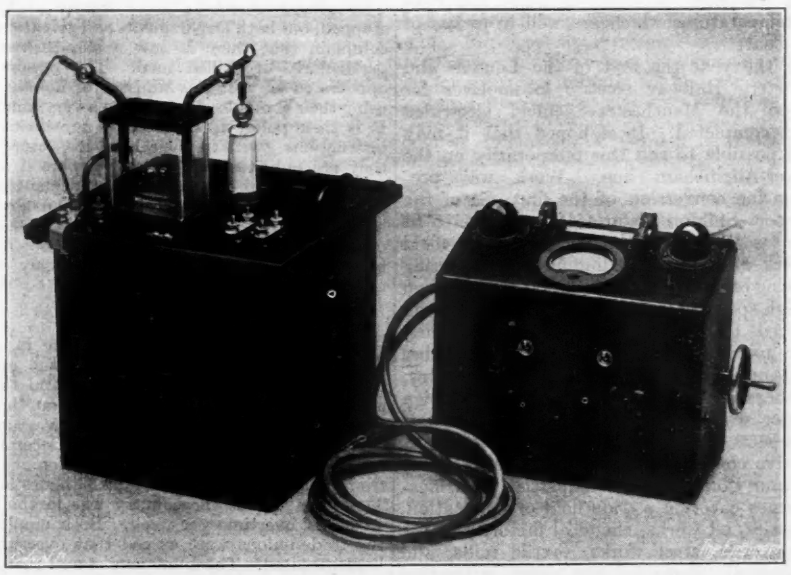

FIG. 18—PORTABLE HIGH VOLTAGE TESTING EQUIPMENT—FERRANTI

An order received by the same firm for six large A.C. variable-speed torque-reaction dynamometers is of special interest in two ways; in the first place, the machines are A.C., whereas previous variable-speed dynamometers of appreciable size have been D.C.; in the second place, these sets mark an extension in the size of B.T.H. stator-fed A.C. commutator motors, type C F. It is the use of this particular type of variable-speed motor that has made it practicable to construct successful variable-speed A.C. dynamometers. These six sets are rated at 300/300/100 H.P., 1120/960/320 r.p.m., for a three-phase, 50-cycle, 400-volt supply.

A new portable high-voltage testing equipment for oil-testing and other general insulation work was put on the market by Ferranti, Ltd., during the year. In this equipment the size and weight of the apparatus have been considerably reduced, whilst the technical performance is claimed to have been greatly improved. The weight is only a third of the corresponding apparatus built ten years ago. The equipment is built in two units, shown in Fig. 18. The right-hand unit includes all the control gear and a moving coil voltage regulator. This unit is also sold separately for the control and regulation of small testing equipments of all types. The right-hand unit includes a high-voltage transformer and the oil-testing spark gap. It is made in two standard sizes giving 35-kV and 50-kV outputs respectively, with, if desired, series parallel connection. The equipment complies in every way with British Standard Specification 148—1933 for the testing of insulating oils. In particular the design is such that the high-voltage wave form is sinusoidal, the errors being guaranteed within the limits of B.S.S. 148, which only permits a maximum deviation of 2½ per cent.

The work of the research department of the Metrovick Company was affected by the increase in industrial activity experienced during the year, whilst war-time conditions introduced many new problems. Whereas certain branches of fundamental research had to be restricted, engineering investigational work included work on the phenomenon of internal discharge in paper bushings, the causes of high-voltage surges on electric arc furnaces, the control of crystal orientation in magnetic materials, magnetostriction effects, the development of an objective noise meter, and the examination of further possible ways of reducing motor and transformer noise.

Increased activity in the steel industry, the same firm states, led to large orders for rolling mill auxiliary motors. The company can now supply mill motors from 10–150 H.P., strictly interchangeable with motors of American design and rating. During the year the insulation of the D.C. mill motors was greatly improved by the substitution of woven glass tapes for asbestos tapes. The glass tape, which is made in this country, is more uniform than asbestos tape, and when used in conjunction with the recently introduced synthetic varnishes has greatly improved electrical characteristics. Investigations carried out during the year have demonstrated that machines can now be built to withstand continuous temperatures which are well in excess of 120 deg. Cent.

During the year the first of the London and North-Eastern Railway electric locomotives for service on the Manchester–Sheffield electrified lines was completed. It is hoped that it may be found possible to run this temporarily on the Manchester-Altrincham line. Work was proceeding on the conversion of the first one of the old Newport–Shildon electric locomotives to fit them for service on the Manchester–Sheffield line. Work was also proceeding in the engineering and drawing offices on the completion of the design of the high-speed passenger locomotives that will be required for the Manchester–Sheffield lines. The war unfortunately closed down a number of projects on electric traction work in this country, though there are others abroad on which design and tender work is active and which hold out good prospects of coming to fruition.

Extensive contracts were undertaken by Bruce Peebles and Co., Ltd., for industrial electrification schemes covering a wide field of application, *e.g.*, collieries, oil works, chemical factories, paper mills, breweries, steel works, textile mills, and food factories. Some of the more interesting orders received were for nine 1900 H.P. slow-speed synchronous induction motors, duplicates of twenty-one previously supplied; a 1450 B.H.P., 1500 r.p.m. A.C. motor for a Scottish coal mine, and thirty-six A.C. motors in various sizes from 55 B.H.P. down to 5 B.H.P. and control gear for a steel works in Scotland.

The majority of contracts secured by the hydraulic department of the E.E.C., as was to be expected, were for export. Contracts included plant for installation in Mauritius, Newfoundland, Rhodesia, Tasmania, and Turkey. The water turbine generating sets range in size from 17,600 H.P. horizontal-impulse units for operating at 500 r.p.m. under 1070ft. head to 2850 H.P. horizontal-reaction sets for operation at 514 r.p.m. under 173ft. head.

The first of the two 23,000 H.P. vertical-shaft hydro-electric sets for the Public Works Department, New Zealand, was put into commission satisfactorily and is now on commercial load.

The twelve motor-coaches and sixteen trailer coaches made by the English Electric Company, Ltd., for the Waterloo and City lines of the Southern Railway were put into service. It is interesting to note that in 1899 Messrs. Dick, Kerr and Co. (now part of the English Electric Company's organisation) supplied five single motor-coaches which were used for maintaining the non-rush-hour services.

Orders were received by the Brush Electrical Engineering Company, Ltd., for two large turbines, one of 50,000-kW for a station where there are already two turbines of almost equal capacity, and one of 37,500 kW, which is a repeat order, for another British power station. Orders were also received for a number of 15,000-kW and 20,000-kW turbines.

Among orders received for alternators were a typical engine-driven alternator and exciter, 166 kVA, 500 r.p.m., 415 volts, 50 cycles, three-phase supply, arranged for direct coupling to a diesel engine; a turbine-driven salient-pole alternator for power supply in an aluminium works; a marine auxiliary generator set driven by Petter "Superscavenge" engine, with an output of 75 kW at 220 volts, specially co-ordinated in design between engine and generator for space and weight reduction; and a water turbine unit for an important hydro-electric station connected with the production of aluminium. The latter set was satisfactorily tested at 90 per cent. overspeed, equal to 1520 r.p.m. The total output of the set is 630 kW.

A recent order for switchgear was that for a switchboard for a well-known spinning company. It controls a bulk supply from the Corporation and a number of feeders to various parts of the mill. A particularly interesting installation was that made in a large engineering works in the West of England. Previously the supply for factory service was from a reciprocating engine driving a D.C. generator with a secondary L.T. A.C. supply from the Corporation. The installation of new multiple-unit machine tools with individual drive and large testing equipment necessitated new A.C. services, and arrangements were made to take the E.H.T. bulk supply from the Corporation for factory requirements. The Brush Electrical Company received the contract for the entire sub-station equipment, namely, the E.H.T. bulk supply ring main switchgear, E.H.T. and M.T. control boards, transformers, a motor generator set with liquid starter, and new D.C. switchgear.

National Expenditure

THE Select Committee which is examining parliamentary war expenditure has adopted and published a report by a Sub-Committee on Supply Services, of which Sir Herbert Williams is chairman. This report deals with many aspects of factory production of war material. Its contents are summarised below.

The Sub-Committee is composed as follows:—Sir Herbert Williams (Conservative), Sir John Wardlaw-Milne (Unionist), Sir Ernest Bennett (National Labour), Mr. Bossom (Conservative), Mr. Edwards (Labour), Mr. Hely-Hutchinson (Unionist), Mr. Woodbury (Labour).

I. Enticement of Labour

Enticement of engineering personnel was prevalent in the early stages of the war, and resulted in disturbance to production. The banning of advertisements for labour put an effective stop to this practice. But there has been one unexpected result. "Poaching" seems to some extent to have been stopped, but both Departments and private employers complain that there is now a standstill of labour, particularly of skilled men. The reason for this appears to be that the Ministry of Labour are only using their compulsory powers to a very minor extent. It is their policy to proceed by agreement and the instructions given to their local inspectors are that they are only to use their full powers if absolutely necessary. The Sub-Committee concur that agreement, if it is possible, is better than compulsion; but they consider that care should be observed that undue delicacy in this matter should not be allowed to cause unnecessary and harmful delay in getting maximum production.

II. Overtime

Before the increased drive began in May the Sub-Committee were perturbed at the amount of overtime which was being worked, and they heard a considerable amount of evidence on the subject. Figures were supplied to them of the average amount of overtime worked by engineers in December, 1939. Great variations occurred in different districts, from 5½ hours in one factory to 22 hours in another. The average over the country was in the region of 12 hours' overtime per week. Both employers and the trade unions were agreed that overtime was to be deprecated. The employers stated that they had an agreement with the unions that normal overtime should not exceed 30 hours in any one month, and that they had not at that time (March), as a Federation, made any attempt to have those hours extended. Excessive overtime led to unrest, fatigue, and sickness, and was not good for production. Government factories were also finding that industrial fatigue was setting in, which showed itself in an increase in the sickness rate. On the other hand, if a certain amount of overtime was not worked, men left their factories for others where they could earn more by working overtime.

After the invasion of Holland and Belgium the Government made a strong appeal for extra work and factories were working 24 hours a day, 7 days a week. The Whitsun and August Bank holidays were cancelled, as were also the local "wakes" customary in some parts of the country. The result at first was an undoubtedly big increase in output. The cry that the country was in danger had a great moral effect, which resulted in a quickening of the "stroke." More work was done in an hour than previously, and the Sub-Committee are glad to learn that this seems to have continued. After two months of extreme effort the expected symptoms began to appear. Absenteeism became much more common, and men arrived late for their work. Sunday labour led in some instances to men taking a day off in the middle of the week, when, of course, they only lost an ordinary day's pay and earned double pay on Sunday to make up for it. In the Royal Ordnance Factories absenteeism rose from 10 to 15 per cent., and at the end of July it was decided, wherever possible, to discontinue Sunday labour and very often Saturday afternoon as well. The result was immediate. Timekeeping improved and production did not suffer. The Sub-Committee were told of one factory where, after the reduction of hours, they set up a new record for one week's production.

The Ministry of Labour are aware that excessive hours are undesirable, both physically and economically. At the end of July they issued a document, which was compiled after prolonged consultation with employers' organisations and the trade unions and the Production Departments. In a foreword the Minister of Labour said: "It is still of vital importance to maintain war production at the maximum. It is of equal importance, if this end is to be achieved, to relieve the strain on workpeople caused by long and continuous hours of work, and for this purpose an adjustment in the present long hours of work is essential." The document recommended an immediate reduction of hours to an average of 60 hours a week, with the aim of a further reduction to 55 or 56 hours a week (which experience has shown to be the optimum standard) as soon as the necessary labour force had been acquired. It was also stated that the rules of the Factory Acts relating to the hours of women and young persons would be again applied as from August 1st.

The Sub-Committee wholeheartedly endorse the opinions set forth in this document. They are of the opinion that it is of vital importance to reduce the hours of work, and they recommend that the ultimate aim must be the introduction of the three-shift system wherever possible. They have received striking evidence from one firm, which has introduced this system. The firm in question employ eight men for seven men's work, so that while the machines are kept working the full 7 days each man has one day off a week, and their total hours are 48 per week. As a result, they have almost no absenteeism, and their production has been more than doubled. In addition, the cost per unit of production has, if anything, been reduced.

To sum up, there are four general facts which may be stated:

(1) Increased hours of work above an optimum which varies slightly with different industries do not increase output proportionately and may even result in a decrease.

(2) When heavy overtime is worked for prolonged periods the general health of workers is undermined.

(3) If overtime has been prolonged a reduction in hours will increase output, though there will be a time lag corresponding to recuperation of energy.

(4) If general health is undermined a reduction to optimum hours will fail to effect the required increase of output.

It is vital, therefore, that reduction of hours should take place immediately, before the health of munition workers is seriously affected, as happened in the last war. In one factory, recently visited by the

Sub-Committee, difficulty is already being experienced from the loss of female labour, due to fatigue arising from the long hours which are being worked. Moreover, it is essential that any reduction should be generally applied, in order to prevent men moving from one factory to another in search of longer hours and more pay. The Ministry of Labour is obviously the body to supervise hours of work, and they should be given powers, if they do not possess them already, to secure a greater uniformity of hours throughout the country. The Supply Departments should not be able, except for short periods, to deal with an emergency, to demand the extension of hours of work beyond whatever length of time should be laid down as the normal.

Evidence has also clearly shown that fatigue may be alleviated by proper attention to the conditions under which work is done, as well as by actual reduction of hours. In these short days it is of paramount importance that close and continuous attention should be paid to the lighting and ventilation of factories and workshops. Evidence has been given which indicates a risk that eyestrain may become a serious problem in itself, apart from the fatigue caused by it, if the inadequate methods of lighting at present existing in some cases are permitted to continue.

III. Dilution and Training of Labour

The main obstacle to the abolition of excessive overtime is the shortage of labour, especially skilled labour. The remedy for this is dilution and training. At the beginning of the war an agreement for dilution was arrived at between the employers and the unions, but for a long time progress was very slow, owing to the multitude of safeguards which surrounded it, and also neither employers nor employed were always free from blame. Employers, when they had skilled men, were not, and indeed still are not, keen for them to leave. The unions, remembering the state of the engineering industry after the last war, were not anxious for the ranks of their workers to be swelled by an influx of men, calling themselves skilled and so qualified for a high rate of wage, who were not in reality up to standard. There was also the problem, as in the last war, of skilled men doing semi-skilled productive work on piece rates, because such work earned better wages. An attempt was made to remedy this in 1917 by the notorious 12½ per cent. bonus to time workers which proved such a disastrous failure.

The Sub-Committee are glad to note that the situation is improving, and that the movement towards a graded system of dilution is increasing. More women workers are being taken on; but the Sub-Committee consider that there should be a continued drive to attain the maximum dilution of labour. This really involves a system of grading engineers into categories based on skill and qualifications, so that every worker is, as far as possible, contributing his highest skill. They are aware that employers are apt to object to too great a scaling down of standards, and that many consider that they have too few skilled workers already. They were informed in evidence in March that the proportion of skilled workers in the engineering industry was about 38 per cent. of the total number of workers. On the other hand, at one factory they visited they were told that 50 per cent. of the employees were skilled. At first sight, therefore, it would appear that this was at that time too great a proportion, although they realise that it is not possible in an industry so varied as the engineering industry to lay down any hard and fast rules. They only draw attention to these figures to make the point that, although there is a shortage of skilled men in many factories, there may be too many in others. The Sub-Committee would again urge, therefore, that the compulsory powers of the movement of labour should, if necessary, be fearlessly used.

Closely bound up with the problem of dilution is the problem of training. In the early months of the war very slow steps were taken to speed up training. In recent months, however, Government Labour Training Centres have at last realised that there is no time for the elaborate systems of training which they at first conducted, and they are now modifying their courses, giving much simpler instruction and so turning out larger numbers of trainees. The Sub-Committee were glad to hear in evidence of the useful work which the technical colleges under the Board of Education are now doing and they hope that these efforts will be largely expanded.

Undoubtedly, however, the best and most practical way of training unskilled labour is in the factories and workshops themselves. Some firms already do this on a large scale, but employers have in the past shown a good deal of apathy. The training of unskilled labour in this way means probably a slight fall in output in the factories where it is taking place, but in order to safeguard future production it is vitally necessary to face this fact. The Sub-Committee consider that all forms of training should be expanded and encouraged in every possible way.

IV. Effect of Overtime on Costs

The primary duty of the Sub-Committee is to investigate "expenditure arising out of the war," and one of the largest items of Government expenditure is that arising from labour costs in Government contracts. The Sub-Committee wish to make it quite clear at the beginning that they are not concerned with the basic rates of salaries and wages, which are regulated by agreements between employers' organisations and the trade unions; but they are concerned with the total earnings which each man and woman receives each week where these earnings indicate abnormalities which *prima facie* are inconsistent with those envisaged in the various wages agreements. The most important normal factor, which increases the total wages over the standard, is overtime; where, therefore, overtime and other extra payments expand costs without achieving a corresponding expansion of production, these become necessarily subject to the Sub-Committee's investigations.

With experience in the past the Sub-Committee cannot help feeling that the present situation ought never to have been allowed to rise. It was conclusively proved that abnormal overtime in the last war increased costs out of all proportion to the increase in production, and they are of the opinion that it is having the same effect now. They have, however, had difficulty in obtaining any figures of costs which relate to the Ministry of Supply, as their system only deals with contracts after they have been completed. Their system is one of post costing, the value of which is diminished by the difficulties of obtaining skilled personnel for such an enormous task, the dangers of hampering production itself by diverting the attention of managements to the compilation of statistics instead of concentrating them on efficient production, and the possibility of elaborate costings becoming themselves a great waste. The Departments have no power under their contracts to examine the current cost of production. In the case, for example, of abnormal amounts being included in a firm's costs for wages, they might report the matter to the proper authority, viz., the Ministry of Labour. It has been laid down that Supply Departments are not concerned with rates of wages. It is, however, claimed that unduly high labour costs, when discovered by the costings investigators, are disallowed. In practice, however, so many complications exist that such checks are impracticable except in a few cases. In the case of certain shells, for example, one firm produced them with a labour cost per shell of about 1s. 5d. against another firm's 5s. 1d. One explanation given was that the former firm was able to utilise less highly skilled labour which could not be obtained by the second firm. The Sub-Committee intend to pursue inquiries into such discrepancies. In theory criticism of all the items of costs undoubtedly lies with the costings departments, but in practice they cannot exercise their power till it is too late to apply remedies; unless some immediate check is effectively made, it is difficult to see how waste in one of the biggest items in all contract prices can be prevented.

Some contracts are still being place on a cost plus a percentage basis, and they provide a temptation to employers to offer unjustifiable inducements to personnel, often to the detriment of national production. Nor are contracts for cost plus a fixed profit much better, for the pressure of production plus the overwhelming nature of the task will tend to make the cost investigators accept abnormal labour and other costs without much argument. Moreover, the 100 per cent. Excess Profits Tax removes one great inducement to be careful of costs, for any expenditure, even of a wasteful character, becomes an expenditure of money which would otherwise be payable to the Treasury in the form of Excess Profits Tax.

V. Costs

Much time and thought has been expended by the Treasury and the Supply Departments on the question of prices, but the primary object seems to have been to prevent contractors making undue profits. Profit in some cases may be only a small fraction of the total price of an article and a far greater economy may be achieved if waste is eliminated from the total cost of the product. Since the introduction of the Excess Profits Tax this question of costs has become even more important, because it is now incumbent on the Supply Departments to see that the price fixed is not too large, as almost all incentive to economy on the part of the manufacturer has been removed by the fact that any extra profit he may make is taken away. The information gathered by the present system of post costing reaches the Departments too late to be used to the best advantage either in keeping a constant watch on costs or in fixing prices for immediately succeeding contracts. It appears, therefore, to the Sub-Committee that it is more than ever essential that the costing department should be able to investigate costs at the time rather than that they should wait, as they are now bound to do, for a contract to be completed before they cost it. Their present method of working has meant that the Sub-Committee have so far been unable to see the actual costs of almost any articles which have been delivered since the war began, so that they have been unable to find out so far whether in their judgment the State is in fact paying too much for its war supplies.

They have, however, been provided with interesting tables showing costs which have been taken out between the years 1936 and 1939 inclusive, and they have been startled to observe the wide range of prices at which the State has been purchasing certain supplies. In some cases it would appear that the costs of some firms are more than twice as great as those of other firms. Several reasons have been advanced to them in evidence for these discrepancies. There is first the question whether plant has been supplied by the Government or whether the firm has supplied its own. Secondly, initial contracts are invariably more expensive, and it was stated that they should be regarded as educational orders. This argument the Sub-Committee fully appreciate, but in one case they observed that after the first educational order there were repeat orders at intervals varying from fifteen months to six months in which the costs of this firm were still nearly twice as great as those of some others. In each case the comment was made that the high price was due, amongst other things, to high labour costs and obsolete plant, and no action appears to have been taken. The firm in question is still receiving orders. Moreover, under the system of post costing, costs are inevitably taken out on (or more often long after) the completion of a contract, and a repeat order must be placed before the full facts are known if a break in production is to be avoided.

Another explanation is that before the war it was difficult to find engineering capacity. The Sub-Committee are unable to accept this justification in its entirety. They are aware that firms were not always willing to turn themselves over to war production while there was still a chance for them to continue in their normal trade; but during 1938 and the early part of 1939 the engineering industry was definitely underloaded, and the Sub-Committee have not yet had evidence that a sufficient search was made to find more efficient capacity. At the present time, when it is necessary to develop all the capacity which is available, it is difficult to withhold orders from any firm, but if inefficient firms had been dropped before the war, when there must have been a surplus capacity, beneficial results would have ensued, not only at that time, but in the future.

The main impression which has been left in the minds of the Sub-Committee so far is the necessity for the costings department to obtain some form of current costings. Their present system, although valuable, produces statistics so late, that it must be very difficult for the production and contracts departments to exercise any real check on the efficiency of firms. It has been stated in evidence that it would not be possible to obtain any figures which give a true picture before a contract is completed. The Sub-Committee have, however, been provided by one firm with the figures which they get out for their own benefit every month. The firm goes into great detail and it would be possible at a glance to discover if anything was amiss. The Sub-Committee realise that it is not possible for every firm to produce such figures, nor, indeed, would it be necessary, in order to obtain the information wanted, to go into such detail. But they are convinced that many of the larger firms must produce some figures on the same lines for their own information, in order to run their businesses in an efficient manner. It does not appear to have occurred to the Ministry that such information would be obtainable, or useful if it were obtained. The Sub-Committee, however, feel very strongly that it is essential in order to exercise a real check on expenditure, and they recommend that an effort should be made to obtain such figures in as many cases as possible and that the duty of examining them should be definitely imposed on those responsible for placing further contracts.

One of the major problems of the placing of contracts is the avoidance of any break in production. The contracts department have stated in evidence that it is the usual practice to place a further contract with a firm about ten weeks before the current contract is completed, but that the difficulty or otherwise of obtaining raw materials may lead to variations in this practice. It is obviously of great importance to ensure an even flow of output, not only from a production point of view, but also from the view of economy. Complaints have been made to the Sub-Committee that such an even flow is not always assured. One example was cited in which an interval of three months elapsed between the completion of the first batch of a certain store and the ordering of the second. The delays in subsequent orders were not so great, but in no case was an order placed well before the completion of the previous contract. The Sub-Committee cannot urge too strongly the importance of the better planning of supply in this respect. There seems to be delay in the Supply Departments in making up their minds as to the eventual numbers of particular articles which will be required, and it becomes impossible for the Contracts Department to place contracts at the most economical prices. Such delay also exasperates contractors, some of whom have been known to continue in production without receiving further orders, in the virtual certainty that eventually they are bound to receive them; but such a course is the exception and one which the majority of contractors cannot be expected to follow.

The National Safety First Association has changed its title to the Royal Society for the Prevention of Accidents.

The Engineer

JANUARY 24, 1941

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THE COST OF MUNITIONS

THERE was published last week a Parliamentary Report, of which the major portion is reprinted elsewhere in this issue. It is a Report of especial interest to engineers and demands their earnest attention, not only because it affects their pockets, but because it touches upon industrial and economic problems in which they are deeply concerned. It was prepared by a sub-committee of the Select Committee on National Expenditure. There are seven members of that sub-committee, of whom Sir Herbert Williams, the Chairman, is an engineer, one is a writer on industrial subjects, one is an expert in engineering and ironfoundry costing, one is an architect and the remaining two are interested in finance and banking. Three out of the seven are members of the Labour Party. On the whole, not a bad committee for the terms of reference. Its work has been well and thoroughly done, as everyone who reads the Report will agree. We will not say that it covers every point in an exceedingly complex subject, but that it handles the principal problems with broadness and accuracy cannot be denied. On one point we may take this opportunity to make a comment of fairly general application. The Report opens with an historical review in which the industrial conditions during the Four Years' War are reviewed. We have omitted this section from our reprint. Conditions have so changed since 1914–18 that we are doubtful about the value of such a review. History never really repeats itself, whatever the old saw may say. There is always something new by which the present differs from the past. We have to deal with things as they are in our day, and the lessons that we can learn from the past are often, not invariably, of comparatively little value. To look back over our shoulders is a natural weakness, but we ought to be cautious about putting too much reliance on what we see. It is more important to look in front of us. In this connection is it not strange that we still use 1914 as a datum year, just as if everything in the intervening quarter of a century were abnormal and unstable?

The Report is divided into several sections, but all bear on the question of cost. Thus, much attention is given to overtime and its effect on the rate of output and the total cost of the unit produced. It is now well known that excessive hours of labour induce weariness, inattention and inaccuracy, and ill-health. As a result the rate of the output per operative falls after a certain optimum number of hours per week are worked. To that direct loss there has to be added the increased cost per unit owing to the overtime rate. This is all familiar experience. It is equally well known that under great emotional stress men are capable of making extraordinary exertions for a time, but ultimately a reaction sets in. That happened after the invasion of Holland and Belgium. The Ministry of Labour called for a twenty-four-hour day, seven days a week, with no breaks. For a couple of months the men responded splendidly, but then the familiar symptoms appeared. Absenteeism increased, men arrived late, and took a weekday off, but worked on Sundays for double the pay. In the Royal Ordnance Factories absenteeism rose to as much as 15 per cent. and it was wisely decided to cut out Sunday work altogether and in some cases the Saturday afternoon as well. The outcome was not a reduction, but an increase in output. Then the Ministry of Labour, on the advice of employers, trades unions, and production departments, recommended an immediate reduction of hours to a maximum of sixty per week with a further reduction to fifty-five or fifty-six, which had been found to be the optimum standard, in view. The Sub-Committee endorses this recommendation, but goes still further. It advances a specific case in support of a forty-eight-hour week—total time—and recommends that "the ultimate aim must be the introduction of the three-shift system, wherever possible." That is, we fear, a counsel of perfection. In certain branches of engineering, and in some shops in many factories, work is continuous, but taken as a whole our information leads us to believe that it has been found impracticable to apply the three-shift system generally. Allied with this problem of overtime is that of the dilution and training of labour. "The main obstacle to the abolition of excessive overtime," says the Report, "is the shortage of labour, especially skilled labour." If there were plenty of skilled men there would be less difficulty in working double and treble shifts. The Sub-Committee was informed in March that the proportion of skilled workers in the engineering industry was 38 per cent. of the total number of workers, and in one factory it visited it was told that the proportion was as high as 50 per cent. That is quite conceivable. Some classes of work call for a much higher proportion of skilled workers than others. But, assuming for the moment that the definition of "skilled" is precise and that a munition factory is visualised, then it would seem not improbable that, as the Sub-Committee suggests, there may be too many skilled men in one factory, whilst there are too few in another. We understand that this matter is being examined. But this may be said, that if as high a proportion as 38 per cent. of skilled labour is required for repetition work of the nature of shell production, then there is something wrong with the methods employed or the designs. There is no reason at all to doubt the ability of practically unskilled and untaught female labour to learn simple operations in the course of a few weeks. Elaborate training is not called for and we are glad, with the Sub-Committee, to note that "the situation is improving and that the movement towards a grading system of dilution is increasing."

All this leads up to the question of costs, which is the main subject of the Sub-Committee's investigations. Its views are conveniently summed up in a short paragraph which is worth quoting in full. "Some contracts are still being placed on a cost plus percentage basis, and they provide a temptation to employers to offer unjustifiable inducements to personnel, often to the detriment of national production. Nor are contracts for cost plus a fixed profit much better, for the pressure of production plus the overwhelming nature of the task will tend to make the cost investigators accept abnormal labour and other costs without much argument. Moreover, the 100 per cent. Excess Profits Tax removes one great inducement to be careful of costs, for any expenditure, even of a wasteful character, becomes an expenditure of money which would otherwise be payable to the Treasury in the form of Excess Profits Tax." That really sums up the position admirably. To remove the disadvantages of the present system the Sub-Committee recommends that the costing department should be empowered to take out current costings, making use of the firms' own costing system whenever possible. "It is only thus," it adds, "that any effective check can be made on the cost of a contract, the present system of part costing being too much delayed to be of any real use." In wartime, when the State is the principal purchaser, the ordinary methods of buying and selling may have to go to the wall, yet one cannot avoid the impression that had the E.P.T. been less exacting and had the Government left costing entirely in the hands of manufacturers, it might now be better off than it is. The case as it stands is an example of governmental participation in industry which is not very encouraging.

The Psychology of Discovery and Research

ALTHOUGH we are not completely hostile to industrial psychology as applied to manual workers or operatives, we are convinced that there are bounds to its application, and that if attempts are made by its advocates to pass beyond these bounds the possibility of grave harm being wrought may well arise. In this connection we have read with much interest an article entitled "Some Psychological Problems of the Scientific Worker," contributed by Dr. Charles S. Myers to the January issue of *Occupational Psychology*, the journal of the National Institute of Industrial Psychology. Dr. Myers' article is primarily concerned with the division of scientific workers into several grades, a study of the temperamental and other qualities required in each grade, and the devising of means for improving the methods by which recruits for the several grades are selected and trained. We fully subscribe to the view that industrial scientific workers can be classified into a number of sections. At one extreme there is the brilliant imaginative scientist expending his time in creating and developing new ideas. At the other there is the laboratory worker engaged in carrying out routine tests of raw materials or of articles during or after their manufacture. Between these "research" and "routine" workers, as Dr. Myers calls them, there are several "service" grades, such as those employed in solving minor manufacturing problems as they occur within the factory, or those who undertake research into the complaints or requests received from customers. We accept these divisions. We cannot, however, fully accept the suggestion that, by the application of psychological methods, it is possible, without running grave risks of making frequent mistakes, to examine candidates for industrial scientific work and to discover the particular grades for which they are suited.

According to Dr. Myers "misfits in these various departments of scientific work appear to be not infrequent; by his methods of selection, the industrial psychologist could do much to reduce their number." At the lower end of the scale it is

probably true that the psychologist could find scope for the application of his methods of selection. Machines and instruments for automatic gauging, hardness testing, and other routine examination have been devised which enable work, at one time carried out in the laboratory or by skilled examiners, to be done by operatives with little or no training. At the most, manipulative ability alone is required of them, and in assessing the extent to which candidates possess that ability, industrial psychology has a legitimate field for the application of its methods. It is, however, at this end of the scale that the consequences of a misfit are of least importance and most quickly detected and remedied. If the invasion of industrial psychology into the sphere of the scientific worker is to justify itself it must do so as it relates to the selection of candidates for the higher grades, those grades for which the prior possession of scientific knowledge is essential. Although the bigger part of Dr. Myers' article is devoted to the higher grades of scientific worker it is noteworthy that his remarks are directed towards what may be called the humanitarian rather than the psychological aspects of the subject. He deals with the attitude towards life of the higher grade scientific worker, with the conditions and surroundings which he expects to find in the works at which he is employed and with the consideration for himself and his work which he would desire his employer to show. Concerning the use of psychological methods for the purpose of discovering the suitability of candidates for the higher grades, Dr. Myers has little or nothing of a practical nature to say. Yet what a chance is here for the industrial psychologist to benefit the world! A youthful Watt would be recognised and would not be compelled to expend what should be his most fruitful years in some manipulative or mechanical capacity. A budding Lodge would be subjected to a corrective process which would cure him of his tendency to lose interest prematurely in his discoveries. No Sydney Thomas would ever again be compelled to support himself as a police-court clerk because of the failure of high authority to recognise his ability as a metallurgist. It is certainly to be regretted that Dr. Myers gives us so little of that psychological guidance which would enable us to discover and docket the blossoming scientific genius and to ensure that his incipient merits led to his employment in the correct category from the outset of his career. We would have been partially content if he had indicated the tests by which there might be discovered those scientific workers who, endowed not with genius but with patience and perseverence, would be likely to achieve brilliant results by sustained effort rather than by inspiration. The Perkins and Brearleys of industrial science have contributed at least as much to progress as the Faradays. Yet even in this limited respect we can find in Dr. Myers' article no clear indication of how the psychologists propose to make their aid effective.

It is not surprising to find that industrial psychology is apparently a little dumb when it seeks to extend its methods into the region of high grade scientific investigatory work. Such work is essentially individualistic in its methods of procedure. The ability to perform it is expressed in too many different ways to permit any system of standardised tests to be applied for the purpose of discovering such ability while still latent. The processes which lead up to a scientific discovery cannot be codified. It is doubtful whether the discoverer himself could tell us very much about them. It seems more than doubtful whether they are ever the same in any two discoveries. As for research, it is certainly true that much which is now dignified with that name is largely of a mechanical nature, and is capable of being mechanised in great measure. But in its higher branches, research—even industrial research—requires for its successful prosecution gifts and abilities at least as great as those which lead to scientific discoveries. Discovery may be said to consist of the disclosure of some hitherto unknown effect. By itself it is very likely to remain next to useless until the research worker traces the effect to its cause, measures the factors influencing it, and reveals practical applications for it. The abilities of the true research worker are not less than those of the discoverer and are equally outside the sphere of mechanisation. While we are willing to grant to the industrial psychologist some right to be heard in the selection of the lower grades of scientific worker—the routine grades whose occupation is far more mechanical than scientific—we would view with regret and with some alarm the extension of his aid to the selection of candidates for the higher grades—the only grades to which the term "scientific worker" can truthfully be applied.

Obituary

LORD WAKEFIELD

By the death, on January 15th, of Lord Wakefield, of Hythe, the country has lost a man who, in the course of his life, did much to assist the development of British motoring, aviation and power-boating. Charles Cheers Wakefield was the youngest son of Mr. J. Wakefield, of H.M. Customs, and was born at Liverpool in 1859. Following education at the Liverpool Institute, he entered the office of an oil broker and in the service of his employer travelled extensively abroad. In 1891 he migrated to London and became associated with a large American oil corporation. In 1899 he founded the firm of C. C. Wakefield and Co., Ltd., manufacturers of lubricating oil and lubricating appliances. The business prospered greatly and the success which it achieved enabled him to devote much time to civic affairs and large sums of money to charitable objects.

On the civic side of his activities his progress was rapid. It may be summarised here by saying that he was elected to the Court of Common Council in 1904, served as Sheriff in 1907 and 1908, was elected an Alderman in 1909, and reached the highest honour, that of Lord Mayor, in November, 1915. Passing over his many philanthropic and charitable interests, we would still have to remember him for the encouragement which he gave to the development of aviation in this country from its earliest days. As early as 1910 he took an interest in flying, but it was not until after the war of 1914–18 that the full measure of his support was forthcoming. With his abundant wealth he assisted—and indeed made possible—several historic flights of a pioneering nature, such as those of Sir Alan Cobham and the late Miss Amy Johnson. In addition, he provided scholarships for Royal Air Force Cadets at Cranwell. played the leading part in bringing into being a society for promoting the study of model aeroplane flying, and as a Vice-President of the Institution of Aeronautical Engineers—now incorporated with the Royal Aeronautical Society—presented an annual gold medal for the best invention designed to promote safety in flight. He also assisted financially the late Sir Henry Segrave's attempts on the motor and motor-boat speed records. Typical of his other benefactions was his gift of £10,000 to the Motor and Cycle Trades Benevolent Fund, of which he was twice Chairman.

In 1908 he was knighted and at the close of his year of office as Lord Mayor he received a baronetcy. In 1930 he was created a baron and in 1934 a viscount.

JAMES BROWN

Everyone, in any walk of life, who knew him will have heard with sorrow of the death, on January 14th, of James Brown, of "Scotts," Greenock. He was a very lovable man, who concealed behind a quiet, almost retiring, manner a wealth of knowledge, a spirit of enterprise, and a breadth of human sympathy that are found in few. It is true of him to say that, whether they were his employees, his co-directors or his clients, he was the valued friend of them all.

He was born in Kirkcudbright seventy-nine years ago and does not appear to have had more than a normal Scottish education of that period. He was apprenticed, no doubt at what we should nowadays regard as a tender age, to A. and P. Stevens, with whom he served the usual five years. Leaving them, he went to the drawing-office of James and George Thomson, which subsequently became John Brown and Co., Ltd., Clydebank. Whilst there he won, in 1886, a Whitworth Scholarship, and in 1889, when he was still only twenty-seven years of age, he became engineering manager to Los Astilleros del Nervion at Bilbao, in succession to Sir James M'Kechnie. In 1900 he returned to this country to be manager of Palmers and Co., Ltd., at Jarrow. There he remained for three years. In 1903 he joined Scotts as engineering manager and remained with that firm to the end, rising from one position of importance to another, till in 1914 he was appointed deputy chairman and managing director.

Thus he gave thirty-seven years of his life to one firm, and in the eyes of all engineers he was identified with it. Under his management and with the full sympathy and co-operation of his chairman and directors, the firm advanced rapidly and was always in the van of progress. Brown's principal interest lay in the engine works, and there he was always ready to consider new developments. When the turbine came in he was one of the first to take it up for marine propulsion, and when the internal combustion engine challenged the steam reciprocator he threw himself into the evolution of the new machine. It will be recalled that the M.S. "Dolius," of the Holt Line, which was equipped with the Scott-Still engine, was built and engined by his firm. He also showed active interest in oil-electric propulsion when it came in. In fact, in whatever direction marine propulsion might be moving, James Brown was certain to be found amongst the pioneers. He thus kept up the tradition of a firm whose proud history goes back to 1711 and which from the first had been amongst the few builders of steam marine engines, two of the earliest Clyde steamers, the "Active" and "Despatch," of 59 and 58 tons, respectively, being built by Scotts, whilst in 1825 the construction of steam marine engines was begun.

James Brown was a valued member of many institutions. He was Vice-President of the Institution of Naval Architects and of the Institute of Marine Engineers, a Member of Council of the Institution of Mechanical Engineers, and a member of the Institution of Civil Engineers. He was a C.B.E.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

OTHER FACTORS OF ECONOMIC PRODUCTION

Sir,—Regarding Mr. Tandy's article, "Other Factors of Economic Production," wherein reference is made to mine published September 20th last, entitled "Some Factors Affecting Economic Production," and which confirms the vital need in industry for intensive procedure investigation, and internal co-operation leading towards the common goal so essential to-day—output.

There are several observations that are apt to be misleading calling for comment.

Mr. Tandy reiterates certain remarks made by me and explores the possibilities of failure, eventually climbing to safety by stating that he does not wish to imply unbridled departure from specified procedure.

System is apparently a bogy; system, method of procedure or works routine requires no argument or elucidation to make known the advantages derived therefrom. It is sufficient to indicate that most successful and well-managed concerns depend upon a procedure laid down with sufficient intelligence and flexibility to cater for contingencies that necessitate deviation in special circumstances to obtain the measure of success which is the cost of production; the indication of success, obviously, price.

To change procedure for the sake of variation, to put it mildly, is not conducive to efficiency, but chaos.

While agreeing with me on the question of specifying finish, Mr. Tandy advises that the enthusiasm for surface finish measurement be damped considerably, and apparently does not appreciate the significance or ramifications of μ, the coefficient of friction or the heat generated by unavoidable metal to metal contact together with many technical reasons too numerous to mention here, affecting the performance of the services upon whom we are relying in the present struggle.

Apathy is a foe to be reckoned with, particularly in these days of long hours, but in my opinion is much exaggerated, and drawing from experience, I have found unjust setting of piecework rates and shop conditions are the prime factors. Exceptions there are where special clothing, masks, &c., are required to be worn, where fumes, heat and dust make long hours a nightmare. Here periodic changes are essential.

Mr. Tandy's suggestion relative to sectional bonus payments is not advised and should be abandoned wherever possible; the onus should at all times be placed on the individual. Provided rates are set correctly, such gift bonuses serve no useful purpose

and are an encumbrance in the bonus office, as well as increasing the overheads and the factory cost of the product.

The showcase method of dealing with scrap is an expensive irritation that would not survive trial. Tuition, accurate setting-up, servicing of tools and gauges, combined with adequate supervision are the soundest methods. J. B. SAMSON.

Newark, January 18th.

LOCATING PLUGS

SIR,—I was much interested to read in the correspondence columns of the current issue of THE ENGINEER the article by Mr. Whitehead regarding the formation on the ends of locating pins and plug gauges.

The formation is, in my opinion, one of the most effective, positive and time-saving means of inserting plugs and plug gauges into holes I have had the pleasure of seeing during my long association with the engineering industry.

I think that Mr. Whitehead is labouring under some misconception when he says that the formation which he describes is for the free usage of all and sundry in the engineering industry.

The formation which Mr. Whitehead describes is a registered formation, the sole ownership of which belongs to the Pilot Plug and Gauge Company, Coventry. The firm in whose service I am employed have been using the formation for the past few years, but only by permission of the above-named company.

Should my statement prove incorrect I shall be pleased to see any corrections made through the columns of your excellent and valuable paper.

Keighley, January 14th. W. HARWOOD.

THE WATT BEAM ENGINES AT DEPTFORD

SIR,—I was very sorry to read in the daily papers a day or so ago that the two Watt beam engines in Deptford pumping station are to be scrapped. The reason given is that the scrap is required for the national war effort.

Everything which will help this great effort must be done, but at the same time I think the older one, dated 1812, could be preserved for all time in its original surroundings.

Such preservation has been done in the Fen Country and in Holland (I hope it still is), and I feel that a similar mark of respect to posterity—and those young engineers who will comprise this posterity in the freedom to come—could be made nearer London.

RONALD H. CLARK, A.M.I. Mech. E.

Norwich, January 18th.

OUTPUT OF THE GORING STEEL WORKS

SIR,—The article by Dr. Neumann in the issue of THE ENGINEER for December 13th has been brought to my attention.

The references which are made to the Göring Stahl at Watenstedt and to the Göring Stahl at Linz do not appear to be in accordance with the facts. Although we are not aware of the actual position of the construction of these two plants and their producing capacity at the present time, we do not believe it possible for either of these two plants to have produced the tonnages of iron and steel as stated, and believe them to be greatly over-estimated.

H. A. BRASSERT AND CO., LTD.,
J. MILES, Managing Director.

London, E.C.4, January 21st.

McNAUGHTED ENGINES

SIR,—In the extract from your columns of "Sixty Years Ago," which appeared in your issue of January 17th, it is stated that McNaught's invention consisted of "the provision of a second cylinder situated midway between the crank shaft and the main centre, this auxiliary cylinder taking steam exhausted from the first." During my apprenticeship in Lancashire I worked on more McNaughted engines than I care to remember, and in every case the McNaught cylinder took steam direct from the boilers and exhausted into the main cylinder which drove the end of the beam. The McNaught cylinder was, in fact, a H.P. cylinder grafted on to a standard condensing beam engine. Owing to its position, it had only half the stroke of the main cylinder, and it was of correspondingly smaller diameter. The merit of the invention was that it allowed a higher steam pressure to be used, and therefore more power to be developed from the engine without interfering with the conditions existing in the L.P. cylinder and the condenser. It certainly prolonged the life of the beam engine for very many years.

R. H. PARSONS.

[Our correspondent is correct. The writer of our note was misled by the ambiguous wording of the original article.—ED, THE E.]

Harbours and Waterways in 1940

No. II

(*Continued from page 44, January 17th*)

AMERICA

THE presidential election in the United States in November, resulting in the choice of Mr. Roosevelt to serve a third term as Head of the State, recalls the fact that the Republican candidate, Mr. Wendell Willkie, was the leading figure in the fight waged by the American utility corporations and companies against President Roosevelt's Tennessee Valley project and other vast schemes of power development, financed from Federal funds, which were, and are, regarded by a considerable section of the business community of the United States as confiscatory in character in relation to existing interests. We remember Mr. Willkie's vigorous and able attack on the Tennessee Valley project during the sessions of the World Power Conference at Washington four years ago.

United States Naval and Air Force Bases

The opposition in both the Senate and the House of Representatives to some parts of the proposals, laid before Congress by the United States Administration in 1939, for the expansion of naval and air force bases on the coasts of the United States, in the Carribbean and in the Pacific, rapidly lessened in the following year as the menace to America of Germany's war aims became more and more apparent. The various proposals, involving expenditure on a vast scale, for the construction of submarine bases, other naval establishments, and seaplane and aircraft bases in parts of the Pacific Ocean, and on the American continental coasts, as well as in the areas recently leased to the United States by the British Government in Newfoundland, the West Indies, and British Guiana are so numerous and the available information concerning them is so confused that an accurate and concise summary of the plans is not practicable at present.

The Panama Canal Locks

The building of a new and larger set of locks to supplement the existing twin locks of the Panama Canal was mentioned in our review of the year 1939 as having been approved by Congress. The cost of the locks and other new works in the canal zone was estimated to be 277 million dollars; but in February, 1940, the Appropriations Committee of the House of Representatives interviewed and rejected the budget appropriation required to enable construction work to be begun. In spite of the vigorous statement on the necessity of the works made by the President after a visit to the Panama Canal in February, the Committee refused to approve the expenditure on the ground that the work, which would take six years, "can hardly stand as an urgent defence measure."

In May, however, this decision appears to have been modified, for the Senate approved expenditure on a scale sufficient to enable construction work to be begun. The new locks will be sited some distance away from the existing locks so as to reduce the risk of simultaneous enemy damage to both entrances.

Dry Docks for the United States Navy

A dry dock, large enough to accommodate the battleships "Iowa" and "New Jersey," each of 45,000 tons displacement, which are now building at the Brooklyn and Philadelphia Navy Yards respectively, is to be constructed at the Bayonne Terminal in New York Upper Bay, which has been acquired by the Federal Government. The dock will be 1100ft. long internally, with provision for ultimate extension to 1200ft., and will cost between 12 million and 18 million dollars.

The further deepening of the Delaware River, from the Navy Yard at Philadelphia to the Atlantic Ocean, from 35ft. to 40ft., has been sanctioned by Congress and dredging operations have been begun. This work, which will cost 4,250,000 dollars, is necessary in view of the construction of 45,000-ton battleships at the Navy Yard.

The Secretary for the Navy early in the year placed contracts for the construction of two dry docks at Pearl Harbour, Hawaii, at a cost of 6,259,000 dollars. One dock is to be 1000ft. long and will be able to take in the 45,000-ton battleships now building as well as the largest warship afloat. The other dock will be 500ft. long. Work has been begun and is expected to occupy three years.

New York Harbour

Among the shipping piers reconstructed and modernised in New York Harbour and brought into use during the year is No. 45, on the Hudson River, which replaces the old structures, Nos. 44 and 45, dating from 1890. The new pier, with its superstructure, has cost 1,337,000 dollars. Another new pier, No. 64, at the foot of West Twenty-fourth Street, was opened in May and has cost 1,335,000 dollars.

The merchandise handled in the Foreign Trade Zone, or Free Port, at Staten Island, in the New York Lower Bay, during 1940, is expected to reach a total value of about 200 million dollars. The zone, established in 1937, received relatively little traffic in the first two years of its existence; but towards the end of 1939 the volume of business began to increase rapidly.

The project for the deepening by dredging and rock blasting of the East River channels at New York, from the Brooklyn Navy Yard to deep water in Long Island Sound at Throgs Neck, which was prepared some years ago by the Corps of Engineers, United States Army, has now been revised and enlarged. The original plan was to provide a minimum low-water depth of 35ft. throughout the channel; it has now been decided, in the interests of national defence, to increase this depth to 40ft. The width of the deep channel will vary between 550ft. and 1000ft. The original project has been completed at a capital cost of about 25 million dollars; this sum will be increased to about 40 million dollars when the enlarged project is realised.

The Upper Mississippi

The last of the twenty-six locks and dams constructed to effect the canalisation of the Upper Mississippi was completed in March. The minimum channel depth from the mouth of the Missouri to Minneapolis, a distance of 658 miles, is now 9ft. This great river improvement work has cost about 170 million dollars.

The improvement of low-stage navigation channels, having a minimum depth of water throughout the year sufficient for craft drawing 9ft., carried out in the past few years in the Rivers Ohio and Mississippi and in the inter-State coastal canals inland of the Gulf Coast, added some 6000 miles to the great network of inland waterways in the United States available to the large barges and towboats of increased draught now normally engaged in American inland water transport.

Texas Waterways

Some idea of the magnitude of the works undertaken in the United States, as a part of the present policy of harbour and river improvement, may be gathered from the report of the Chief of Engineers, United States Army, to Congress recommending sanction of an expenditure during the 1940–41 financial year in the State of Texas alone of over 37 million dollars on river and harbour improvement schemes. These include the deepening of the port of Houston ship channel, improvements on the Sabine-Nachez waterway, and the Galveston-Corpus Christi section of the Intra-Costal waterway.

The St. Lawrence Waterway Project

President Roosevelt announced in a message, read on December 6th to the Great Lakes Seaway and Power Conference at Detroit, that he would renew in January the attempt, which failed in 1934, to get Congress to approve the treaty with Canada for the completion of the St. Lawrence waterway and power project "on which so much of our national safety and welfare depends."

Following the failure in 1934 to obtain the approval of Congress to the draft treaty between the two countries, the Canadian and United States Governments had reopened negotiations which, however, were again broken off in 1938. These were resumed towards the close of 1939, and, early in the following year, it was announced that agreement had been reached for the constitution

of a Commission composed of an equal number of representatives of each of the two countries. This Commission will be entrusted with the preparation of plans for the works in the International Section of the waterway. Subject to legislative sanction by the United States Congress and the Ottawa Parliament, it is proposed that the work on this section shall be carried out by the United States Corps of Engineers. The cost of this part of the work, estimated approximately at 56 million pounds, would be borne almost entirely by the United States. The depth of water in the channel is proposed to be 27ft.

The aggregate of the estimates of the cost of the whole project, including the enlarged navigation, the development of electric power, and the further deepening of the Welland Canal, all of which are associated in the scheme, is upward of 82 million pounds, over two-thirds of which would be borne by the United States and the balance by Canada.

AUSTRALIA AND THE EAST

The Sydney Dry Dock

A year ago we recorded the fact that Sir Leopold Savile's report on his investigation of several alternative sites in Australia suggested for the construction of a large dry dock had been presented to the Commonwealth Government. It has since become known that Sir Leopold recommended a site in Sydney Harbour for the dock, the cost of which will be about 3 million pounds. Preliminary work on the site, which is between Garden Island and Potts Point, began in July and the building of the dock is expected to occupy three years. It is to be large enough to accommodate the largest battleship afloat or likely to be built for years to come.

Hong Kong

The Colonial Office announced on August 1st that Sir David Owen, formerly General Manager of the Port of London Authority, had accepted an invitation from the Government of Hong Kong to visit the Colony for the purpose of advising on the future administration of the port. Sir David left for Hong Kong in September and was accompanied by Mr. Duncan Kennedy, lately resident engineer for new works at Beira, as engineering adviser. The terms of reference to Sir David include consideration of the future development of the port and harbour facilities.

Japan

News came from Japan that work is in progress on the construction of a canal 22 kiloms. long with a depth of 9 m. between Tokio and Yokohama.

Rangoon

The completion of the Brooking Street Wharf in the Rangoon River, which the Commissioners of that port brought into use in April, 1939, has been followed by the commencement of work on the third stage of the harbour reconstruction scheme. This comprises the replacement of part of the old Sule Pagoda wharves upstream of the Strand Market wharf. The new structure will have a length of 1380ft. with three transit sheds, each 50ft. in width. The wharf will be similar in character to Brooking Street wharf, the deck being carried on reinforced concrete piles, except on and near the river front, where three rows of screwed cylinders, 3ft. 6in. diameter, penetrating 40ft. to 45ft. below the river bed, support the superstructure.

Recent Developments in Trolleybus Motors

THE early type of trolleybus was regarded by engineers as a "hybrid" between the tramcar and the motor bus. The trolleybus motor was therefore merely an adaptation of the tramway motor, and was consequently heavy, cumbersome, and uneconomic. In the early 1920's, for instance, a trolleybus motor rated at 40 H.P. weighed as much as 1500 lb., or 37·5 lb. per horsepower. The modern trolleybus motor has reduced this weight to about 13 lb. per horsepower. This result has been achieved by the use of lightweight metals, scientifically designed ventilation, and by Class B insulation which has made it possible to allow a higher temperature rise. Compared with the early type, the present-day motor is, for equal power, more compact and suitable for underfloor mounting, thereby effecting a considerable saving in space.

Of the two types of winding, compound and series, the first named is now in most general use in Great Britain. The compound-wound regenerative motor has a wider range of economical speeds than the series type, and its consumption is less dependent on the driver's skill. Although the amount of energy which can be saved by regeneration is still a controversial subject, the principal advantage of regeneration is that it provides a reliable form of braking. Its disadvantages are apparent on systems which are divided into sections fed by mercury arc rectifiers; in that case, if a bus regenerates when it is alone in the section it can, even with an overvoltage relay, burden the line with high voltages.

Engineers have argued that a series winding gives less trouble than a shunt winding. With the development of adequate asbestos covering for shunt wire, however, this argument is no longer as valid as formerly. Experience has shown that very little trouble is encountered with the modern shunt-wound motor.

As an alternative to regenerative braking the London Passenger Transport Board favours rheostatic braking. This is achieved by exciting the shunt field from the line and connecting the armature across a section of resistance. The maximum braking torque is limited by the differential action of the series winding, which can be included in the braking circuit. During rheostatic braking the series field is entirely cut out. It may be mentioned that a number of British transport undertakings are having new trolleybuses equipped with rheostatic braking.

The standard Metrovick M V 202 motor which was first produced in 1932 was among the earliest trolleybus motors to have a single-turn armature winding. It has a one-hour rating of 85 H.P. at 550 volts, and is suitable for four-wheel, double-deck trolleybuses. Its continuous rating is 66 H.P. at 1200 r.p.m. The M V 206 type (Fig. 1) has the following ratings:—95 H.P. at one-hour rating, 80 H.P. continuous; armature at 142 and 120 amperes, respectively, the speeds being 1180 and 1230 r.p.m. Other forms of these motors are specially wound to suit higher demands. For example, for overseas trolleybuses, with laden weights of 14½ tons or over, there is a Metrovick motor giving 105 H.P. at 550 volts, with an armature rated at 160 amperes and a speed of 1200 r.p.m. It is interesting to note that in these special units the increased rating is obtained with change to the full field curve, and therefore the energy consumption remains the same for any given service. In cases where it is desired to maintain a high acceleration above 15 m.p.h., a final speed curve is provided in which the shunt field, after having been reduced to zero, is excited in the reverse direction.

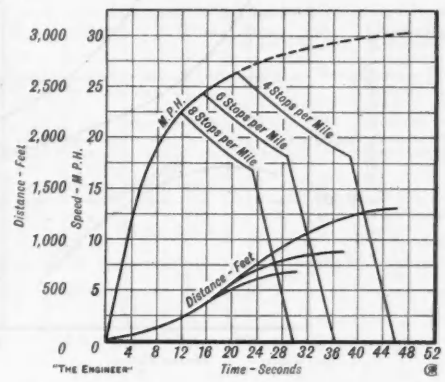


FIG. 3—SPEED-TIME CURVES OF METROVICK MOTOR

The B.T.H. type of trolleybus motor (Fig. 2), first introduced in 1932, has several distinguishing features. The 202 model, suitable for vehicles with a fully laden weight of not more than 12½ tons, has an hourly rating of 85 H.P. at 550 volts, 1130 r.p.m., and a continuous rating of 100 amperes. The 206 A motor is rated 95 H.P. at 550 volts, 1180 r.p.m., at its one-hour rating, and 120 amperes continuously. It is suitable for vehicles weighing up to 13½ tons. For heavier vehicles there is a motor rated at 105 H.P. for one hour, or 140 amperes continuously, suitable for vehicles weighing 13½ to 14 tons laden. It may be noted that the type 206 motor is provided with tapered armature slots, thus enabling more copper to be accommodated in the armature windings while restricting the weight. All motors are available with regenerative or non-regenerative windings.

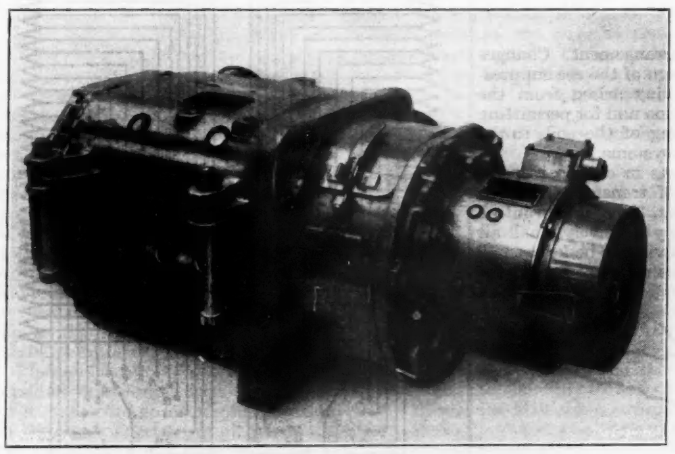


FIG. 1—95 H.P. METROVICK TROLLEYBUS MOTOR

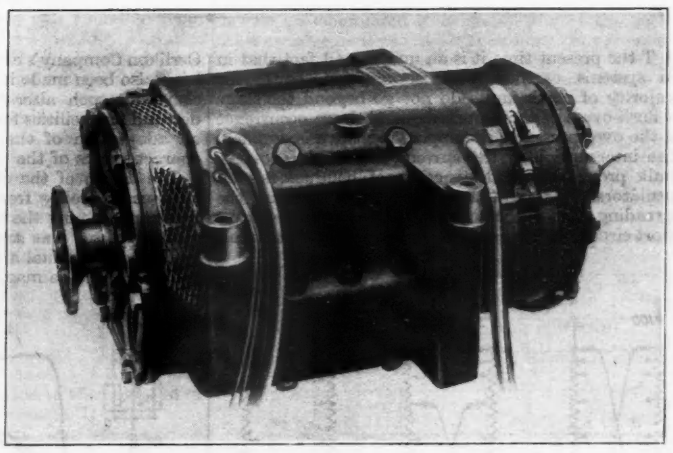


FIG. 2—B.T.H. TROLLEYBUS MOTOR

In the Crompton-West motors, the type of armature slot was the subject of many experiments. After comparing the taper slot with the parallel slot it was finally decided to standardise on the second-named type. It was found in the experiments that the use of a taper slot showed no appreciable improvement in heating or commutation, while the more complicated arrangement of conductors increased manufacturing costs. Other manufacturers have found, however, that the taper slot winding increases the capacity

of the motor by about 10 per cent. for a given frame size.

In the Crompton-West compound-wound motors the series winding is rated in accordance with the full armature current, while the shunt field is rated on an intermediate value of current between the maximum and minimum obtainable. The shunt field current in service varies over a range of approximately 6 amperes to 0 amperes. Characteristic performance is as follows :—With a motor having one-hour rating of 100 H.P. and a trolleybus weighing 12 tons, the acceleration would be 3·5 m.p.h. per second up to a speed of 15 m.p.h. to reach a speed of 30 m.p.h. in approximately twenty-six seconds. The balancing speed on the level would be approximately 35 m.p.h., while a speed of 12·5 m.p.h. could be obtained on a gradient of 1 in 9.

It is interesting to note that Crompton-West research has been concentrated less on armature construction than on the field system. The firm believes that the field system, being stationary, lends itself to greater modification and development than the revolving armature system. Investigation is proceeding on the problems of air flow through the motor with a view to increasing still further the rate of dissipation of losses. Highly efficient fans have been developed which, in conjunction with a balanced design of air passages through the machine, allow air to be directed to the parts where the temperature tends to be highest.

In the two types of motors manufactured by the General Electric Company, the W.T. 25 type (with either series field or compound winding) gives a one-hour rating of 95 H.P., continuous 75 H.P., armature amperes of 115 and 143, respectively, the continuous speed being 1400 r.p.m. The W.T. 26 type shows a continuous power at the shaft of 83 H.P. (105 for one hour) with armature amperes at 125 and speed of 1280 for continuous series, and 1310 for continuous compound field windings. Another compound-wound motor can be made to give 105 H.P. continuous at 1550 r.p.m. All these figures are for performance on 550 volts.

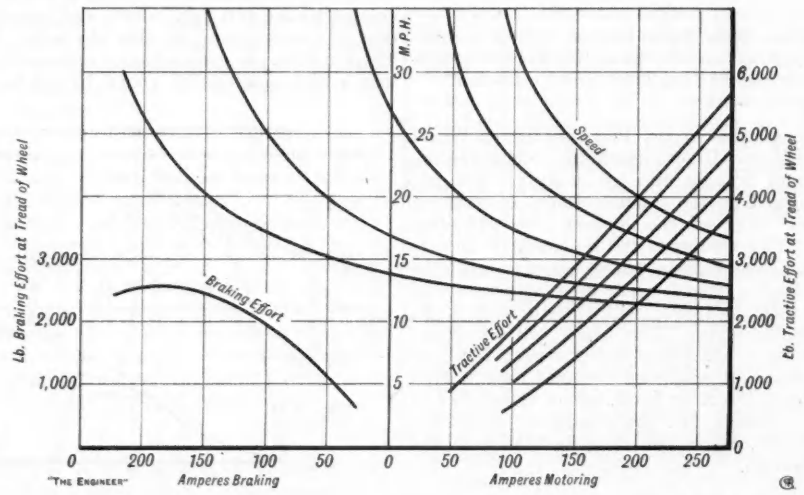


FIG. 4—CHARACTERISTIC CURVES OF CROMPTON-WEST MOTOR

An example of the speed-time curve of a modern trolleybus motor, in this case the Metro-Vick 201 and 202 types, is shown in Fig. 3. This is calculated for the performance of a double-deck bus driven by one motor, the weight of the bus with an average load being 9·25 tons. On a level road the rate of acceleration is 3 m.p.h. per second, and the rate of braking 2·5 m.p.h. per second. The time margin for coasting is 5 per cent. and the tractive resistance is 40 lb. per ton up to 15 m.p.h., increasing to 60 lb. per ton at 30 m.p.h.

The characteristic curves of a compound-wound Crompton-West motor are shown in Fig. 4. The wheel diameter is 39·6in. and the gear ratio 9·33 to 1, with an assumed gear loss of 5 per cent.

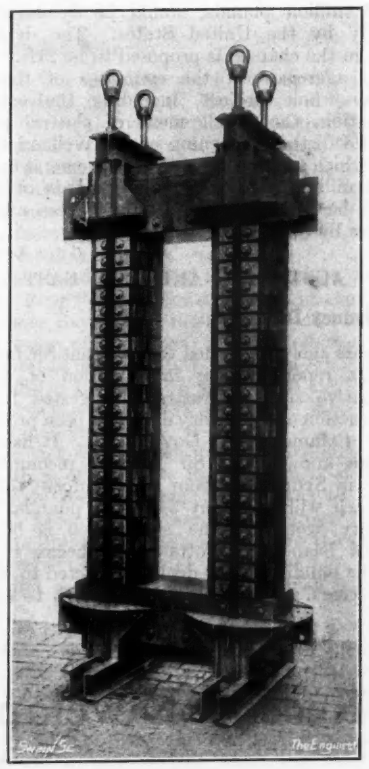


FIG. 3—CORE OF PETERSEN COIL

Petersen Coil Design

AT the present time it is an undisputed fact that in systems earthed with suppression coils, the majority of earth faults do not go beyond the stage of flash-overs of short duration, and the re-occurrence of the over-pressures accompanying them is avoided. The interruption of the current at the place of the fault prevents the destruction of conductors and insulators, the formation of discharge paths and the spreading of the arc to sound phases with resultant short circuit. In the case of a permanent short circuit to earth, the service can be maintained and consequently time can be gained for insulating the faulty places and for taking any necessary measures. The generating plant is not subjected to a single-phase load, disturbances due to harmonics disappear, and the dangerous step pressures at the place of the short circuit to earth are eliminated. The stability of the installation is considerably increased.

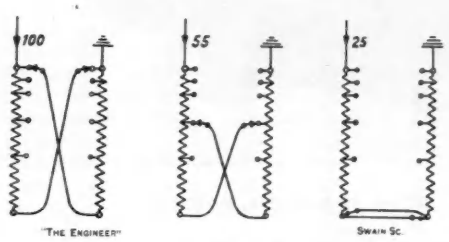


FIG. 1—ADJUSTABLE WINDING

Such alterations as have been made in the Petersen coil principle have been confined to modifying its mode of operation in service, as in the case of the Oerlikon Company's cross-coil arrangement. Changes have also been made in the design of the arc suppression coil, such alterations having arisen from the demand for facilities for regulation and for permitting an adaptation of the quenching of the coils to the characteristics of the different systems.

The design of the coil departs in certain respects very considerably from that of transformers. The iron core forming the limbs (Fig. 3) is divided into a number of sections separated by relatively small air gaps, the individual air gaps having to be kept small in order that the magnetic lines may not spread too far and produce additional losses in the magnetic parts, such as pressure bolts, &c., and, on the other hand, so that the flux shall not be forced over the flat sides of the laminations and give rise to large additional losses in the pressure plate, in particular.

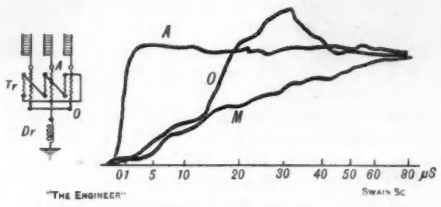


FIG. 2—OSCILLOGRAMS OF COIL ACTION

The laminations are held tightly together between "Avional" pressure plates by two bolts. The height of the individual packets of laminations is kept as small as constructional considerations permit, and in most cases amounts to 70 mm. to 80 mm. The packets of laminations are spaced by insulating plates. The limbs are thus formed of a superimposition of layers insulated from each other, which would be liable to get charged by the coil winding earthed at one end. An equalisation of potential with the yoke is, however, ensured by means of connecting leads, and the units and the yokes are firmly held together by bronze tie rods.

A matter that presents considerable difficulty for the designer is that of providing the wide range of regulation required. If, for instance, the current of the coil must be adjusted in the ratio of 1 to 4, this means that with the phase pressure of the system constant and applied across the coil during the short circuit to earth, the number of turns of the winding must be variable in the ratio of 1 to 2. Thus, for the maximum current, the number of turns must be reduced by half. To provide for the cutting out of such a large proportion of the coil is a difficult problem, for it must be remembered that with ordinary transformers the length of winding carrying tappings is only that necessary to give a pressure variation of

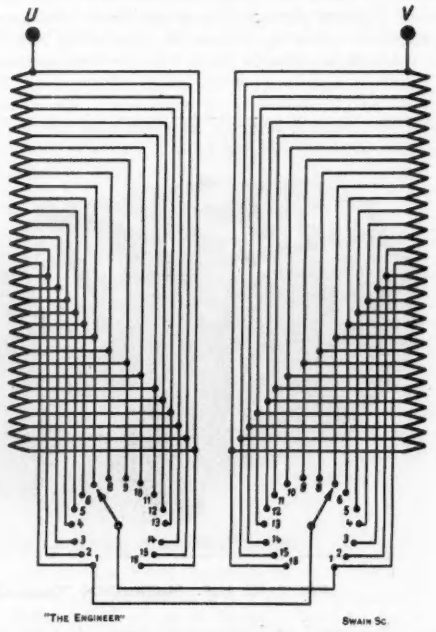


FIG. 4—WINDINGS OF LIMBS

±5, while with regulating transformers the range provided is about ±15 per cent. The provision of larger ranges of regulation is not an easy matter.

Although the problems connected with current forces are not of such importance for arc suppression coils as for regulating transformers, symmetrical design of the windings is retained, as far as possible. The cutting out of such a large section of windings is a matter that has to be considered from three different standpoints. There is, first of all, the question of distribution in space of the magneto-motive forces of

the windings in relation to that of the magnetic resistances of the iron circuit. Secondly, there is the problem of the heating of the coil; and, thirdly, that relating to the pressure conditions in the latter.

To meet the requirements of these three different conditions, the Oerlikon Company has evolved a new type of winding for adjustable arc suppression coils to satisfy the stipulations laid down by the Nordostschweizerische Kraftwerke. The simplest arrangement for an adjustable winding of this description with a current regulation of 1 to 4 is shown in Fig. 1, where the single-phase arc suppression coil has two limbs with similar winding, connected first in parallel then in series-parallel, and finally in series, when varying the current from the maximum to the minimum value, the effective number of turns being altered in the ratio of 1 to 2. The coils can, of course, be built for a smaller range of regulation, the ratio of 1 to 4 being the upper limit.

In order to keep the distribution of the magnetomotive forces of the winding always symmetrical in relation to the ironcore of the limbs over the whole length of the latter, parallel connection has been adopted for the winding of each limb (Fig. 4).

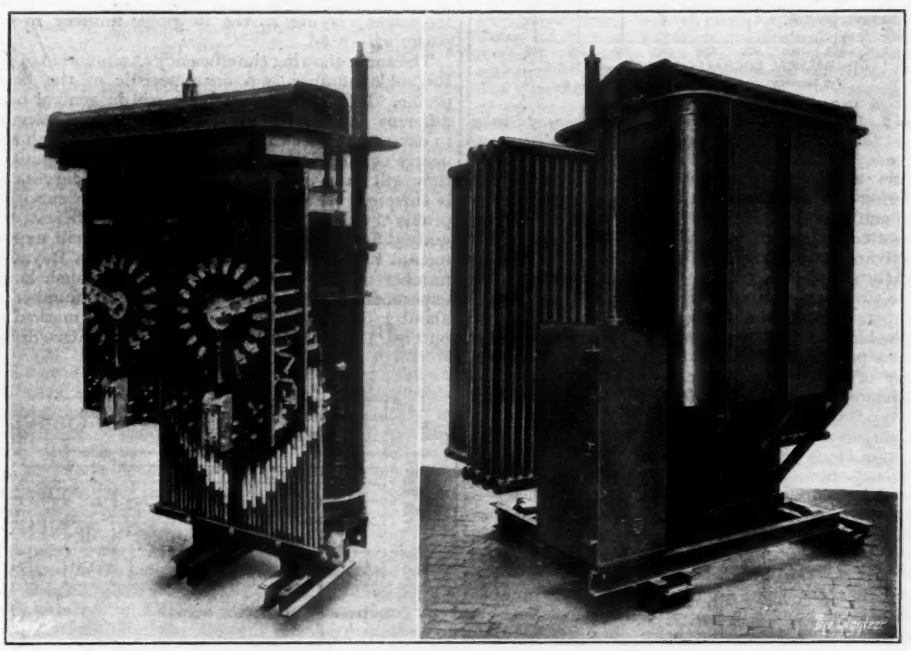
With regard to the dissipation of the heat due to losses, which does not exceed 1 per cent., the coils are designed either for continuous operation or for two hours' service, and it is sufficient to build the tanks with welded-on radiators or even to leave smooth surfaces.

The constructional details to meet the pressure conditions are in accordance with modern transformer design. As a rule, paper insulation is used throughout for the suppression coils, protective rings being fitted at the entrance of the winding, in order to ensure good distribution of the pressure. The coil is connected either to the neutral point of a suitable high-capacity transformer, or to an artificial neutral point obtained by means of an auxiliary transformer. The usual mode of connection is then star-delta with the neutral point brought out, which gives for the neutral point currents a small impedance of the order of magnitude of the leakage pressure of a transformer. Surges in the system arising from storms meet this auxiliary transformer; the travelling waves do not, however, reach the suppression coil in their original form; their shape is altered according to the natural oscillation characteristics of the auxiliary transformer.

The oscillogram (Fig. 2) represents the case of an auxiliary transformer with suppression coil connected to it, subjected to atmospheric surges, which travel in the same direction in all places. Curve A shows the variation of the pressure at the entrance of the windings; the latter correspond to a rectangular-shaped wave, which enters the winding and is reflected at the open neutral point. A neutral point oscillation O sets in. It has a frequency of about 17,000 cycles, which is equivalent to 350 times the working frequency. The third curve M shows the variation of the pressure at the middle point of a phase winding. This point was accessible in the present case.

The new arrangement adopted for the winding of the suppression coil shows a considerable advance, as there are no open portions of winding cut-out, which might serve as possible points of reflection for oscillations, and the winding of the whole limb is always in circuit The portions of windings of the two limbs, which are in parallel for the time being, are well apart and of identical design, from an electromagnetic point of view. Under normal conditions, regulation is done by means of a tapping switch, which is operated when there is no short circuit to earth in the system. Load switches can, however, also be provided.

A typical suppression coil built by the Oerlikon Company and installed in Switzerland is seen in Figs. 5 and 6. It is a 2300-kVA coil for a 50-kV system, adjustable for current of from 20 to 80 amperes, and designed for continuous service.



FIGS. 5 AND 6—2300-KVA SUPPRESSION COIL FOR 50-KV SYSTEM

Reflections

ONCE upon a time, many centuries ago, a philosopher took a walk. It was his custom to add to his wisdom by questioning those whom he met on his rambles, especially the people who were doing things that seemed out of the ordinary. "It is thus," the philosopher said, "that I learn if, why and how people think and what they think about."

The first person that he encountered was a man forming vessels of clay. "Oh, friend," said the philosopher, "what do you think about while you fashion these pots on your wheel?" And the potter replied: "What is there to think about? I have been fashioning pots for forty years and my father and grandfather before me."

The philosopher continued on his way until he came to another man gazing intently at a deer grazing in a field. "What are you thinking about as you gaze at that deer?" he asked. Said this man: "I am thinking that if I had a bow and arrow I could kill that deer and my family could eat meat."

"Have you thought about making yourself a bow and arrow?" asked the philosopher.

"No," replied the man, "I had not thought about that."

Continuing his peregrinations, the inquisitive philosopher arrived at a place where an ox cart driver had halted his vehicle at the edge of a mirror-like pond, and on hands and knees was peering intently at the water. "What see you in that water?" our friend inquired. Said the man: "I see snow-capped mountains and blue sky and white fleecy clouds."

"But why not stand up and look at them, instead of peering at them in the pond?"

"If I did that," declared the man, "I would see only the sky and the clouds. As it is, I see myself, too, and my ox and cart in relation to them, and even the little fishes swimming in the water."

"And what do you think about when you see these things?"

"I think about myself and my ox and cart, and our work in relation to this great world of which I am a part."

Whereupon the philosopher called it quits for the day, having, he realised, added greatly to his store of wisdom.

There may be a thought in this for the men and women of to-day, regardless of their work or positions, who play a part in industry. No matter what part you play, try to see it in relation to the people who work with or for you, your company, your industry and your country.

And there is a thought in this, too, for the people who edit and publish industrial papers. We must provide the proper reflecting surface in which you can see yourself in relation to your environment.—*By J. H. Van Deventer, in "Iron Age," December 12th, 1940.*

Steam Turbine Nozzle and Blading Efficiency*

By F. DOLLIN, B.Sc.(Eng.), A.M.I. Mech. E.†

(*Continued from page 54, January 10th*)

Investigations Made with Nozzle Tester.—The object of the tests is to determine the velocity coefficient, discharge angle, and discharge coefficient for the given turbine nozzles over a wide range of pressure ratio (*i.e.*, of air speed). Investigations have been made both on reaction blading and on nozzles designed for use with velocity-compounded impulse wheels. Attention is directed in the paper to some reaction blading tests which provide an interesting example of correlation by Reynolds number and can further be correlated with dynamic turbine test results. Table I shows the quantities which must be measured, their approximate range of variation in tests on reaction blades, and the methods of measurement.

TABLE I.—*Test Data Required*

Quantity.	Units.	Maximum.	Minimum.	Measuring instrument.
Pressure above atmosphere before metering nozzle	lb. per sq. in.	12·1	0·75	Mercury column
Temperature before metering nozzle	deg. F.	65	50	Mercury thermometer
Pressure drop across metering nozzle	lb. per sq. in.	2·2	0·2	Water column
Pressure above atmosphere before turbine nozzle	ditto ditto	10 2·2	2·2 0·5	Mercury column Water column
Temperature before turbine nozzle	deg. F.	65	50	Mercury thermometer
Atmospheric pressure	lb. per sq. in.	—	—	Fortin barometer
Tangential component of jet reactive force	lb.	27	1·5	Torque steelyard
Axial component of jet reactive force	lb.	12	0·8	Thrust steelyard

The method of mounting reaction blade segments in the nozzle tester is shown in Fig. 6. The segment is soldered into an adapter which is clamped to the nozzle chamber and projects through a shaped opening in a large baffle plate supported independently of the rotor. The inner and outer curved surfaces of the nozzle are chamfered to a narrow rim at the outlet. This arrangement practically eliminates any tendency towards instability or deflection of the jets. The only solid surface that might produce such an effect is the baffle plate, and as this is not attached to the rotor its effect would not be recorded on the thrust balance. The baffle plate has the further advantage of screening the rotor from extraneous draughts that might give a false reading of thrust.

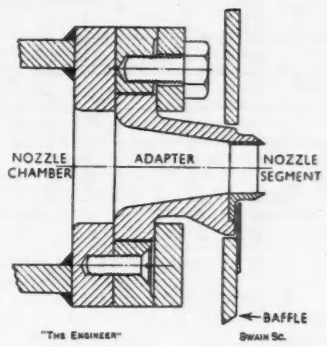
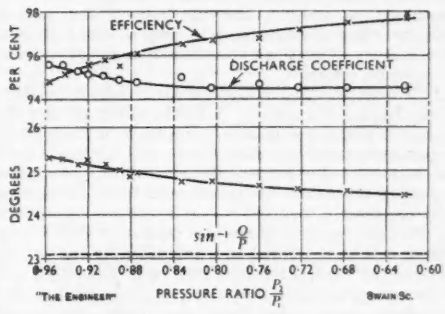


FIG. 6—*Reaction Nozzle Mounting and Baffle Plate*

Before being fitted to the tester each nozzle segment is mounted on a chamber into which compressed air with a trace of steam is admitted. With this mixture the direction of flow of the issuing jets is made visible and any irregularities in the discharge and any leakage at imperfectly soldered or brazed joints are disclosed.



Profile C, ⅜in. wide.

FIG. 7—*Static Test Results on Reaction Blade*

Static Test Results on Reaction Blading.—Fig. 7 shows typical results on a nozzle block comprising a

* Institution of Mechanical Engineers.

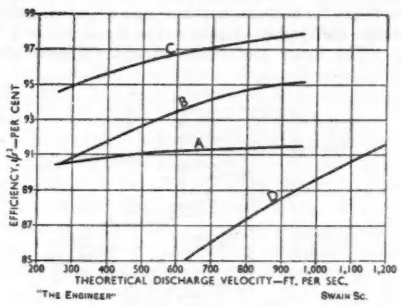
† C. A. Parsons and Co., Ltd., Heaton Works, Newcastle-upon-Tyne.

group of ten reaction blades having an axial width of $\frac{3}{4}$in. and an opening coefficient of about 0·39. The results are plotted as values of energy efficiency (*i.e.*, velocity coefficient squared), discharge coefficient and discharge angle on a base of pressure ratio. A few comments on the general characteristics of these curves may be of interest.

The discharge angle is $1\frac{1}{2}$ deg. to 2 deg. bigger than $\sin^{-1}$ O/P, falling slowly and at a diminishing rate as the range of expansion increases. Similar features were found in the Steam Nozzles Research Committee's tests on reaction blading.

The discharge coefficient similarly tends to fall as the range of expansion increases, whereas the velocity coefficient tends to rise. It is believed that an explanation of this apparent anomaly can be found in an important difference between the flow conditions assumed in calculating the theoretical nozzle discharge and the actual flow conditions in curved nozzles. The theoretical discharge is calculated on the assumption that the pressure in the plane of the nozzle throat is uniform and equal to the final discharge pressure. Actually, a pressure gradient exists across the plane of the nozzle throat, the pressure in the region near the convex blade face being appreciably below the final discharge pressure. This depression will tend to increase the flow through the nozzle by a proportion that is greatest at the smallest expansion ratio and falls to zero as the critical pressure ratio is approached. In this way a rising velocity coefficient can be accompanied by a falling discharge coefficient. It is not entirely clear, however, why with the larger expansion ratios the discharge coefficient is appreciably lower than the velocity coefficient. It may be recalled that interpretation of the discharge coefficients obtained in the Steam Nozzles Research Committee's tests also proved rather baffling.

Chief interest, however, centres in the velocity coefficient and the corresponding energy efficiency, with its rising trend as the range of expansion increases. This trend is characteristic of the results with normal reaction blading, and in no case was a falling trend found at any subsonic velocity. Fig. 8 shows the square of the velocity coefficient for four



Profile.	Type.	Width, inches.
A	Reaction, obsolete	$\frac{3}{4}$
B	,, normal	$\frac{3}{4}$
C	,, streamlined	$\frac{3}{4}$
D	Impulse, cast	$\frac{3}{4}$

FIG. 8—*Static Test Results on Four Different Nozzle Profiles*

different nozzle profiles, plotted on a base of theoretical jet velocity for convenience of comparison with curves published by the Steam Nozzles Research Committee and by Dr. Guy (1939). The relevant particulars of the nozzles are indicated on the diagram. Three of the profiles are reaction blades and were tested in the lower range of air velocity. The fourth is a non-divergent impulse nozzle that was tested mainly in the region of supersonic velocity, but also at the higher end of the subsonic region, as shown in Fig. 8. The two more efficient reaction profiles, B and C, and the impulse nozzle D show a pronounced rise of efficiency with increase of velocity ; the latter, indeed, continued to show a rise far beyond the critical velocity. The other reaction blading profile A showed an efficiency almost constant, but rising slightly with increase of velocity.

It is interesting to consider these results in relation to the Reynolds number. It has been shown that the Reynolds number is an inverse measure of the relative importance of the viscosity forces and it would therefore be expected to become the controlling factor when the losses are mainly due to viscous forces, *i.e.*, when they are mainly confined to the boundary layer. For an efficient reaction blade this condition does occur. The flow is there guided and controlled by the curved faces of the blades, there is little eddy formation and the losses are largely due to the viscous drag on the boundary layer. In these conditions one would expect the efficiency to increase with increase of velocity, since the viscous losses per pound of flow vary as the first power of the velocity and the turbulence losses as the square, making the total losses increase at a slower rate than the square of the velocity, while the kinetic energy of the jet per pound of flow varies directly as the square of the velocity. The expected curve of efficiency would in fact show a continuous rise with a continuously decreasing slope as the velocity increases, exactly as for reaction blade profiles B and C. In tests on any given nozzle the Reynolds number varies almost in proportion to the velocity, there being little variation of kinematic viscosity, and the conclusion is that for a well-designed reaction blade the efficiency tends to increase with the Reynolds number, as one would expect it to do.

The flat characteristic of profile A is probably due to the fact that it has a high degree of curvature near the outlet, and a pronounced rise of pressure along the back of the blade after the throat. It is suggested that this rising pressure gradient plus the viscous force due to surface drag retards the forward movement of the particles in the boundary layer and finally arrests it at what is called the stagnation point. The particles piling up behind then break away from the surface and seek less resistive paths farther out in the stream. At the same time the rising pressure gradient continues past the stagnation point and causes a reversed flow from the outlet edge to the stagnation point, thus generating an eddying region and making the total losses predominantly turbulent rather than viscous. This conception would lead us to expect a flatter characteristic for profile A, but not one crossing profile B or C at low velocities.

Another approach to the experimental study of the effect of Reynolds number is to test geometrically similar passages of different dimensions. Fig. 9 shows, on a base of velocity, the efficiency of two

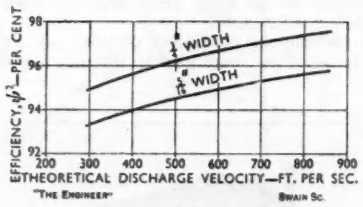


FIG. 9—*Effect of Blade Width on Nozzle Efficiency of Similar Profiles*

nozzle segments of geometrically similar profile, differing only in axial width, which was $\frac{3}{4}$in. in one case and $\frac{3}{16}$in. in the other. The two curves are well separated and nearly parallel, the wider blade having an advantage in efficiency of about 1·7 points, tending slightly to increase with the velocity. In Fig. 10 the same two curves are replotted on a base of Reynolds number, with the striking result that, over a range of Reynolds number they share in common, the two curves practically coincide. This suggests the possibility of constructing a single curve expressing the efficiency of this blade profile as a function of the Reynolds number.

Comparison with Dynamic Turbine Tests.—The reaction blade profile C, to which the curves of nozzle efficiency shown in Figs. 9 and 10 relate, has also been tested in widths of $\frac{3}{4}$in. and $\frac{3}{16}$in. in a small experimental turbine having seven stages, the spindle being 8in. in diameter and the blades $\frac{3}{4}$in. long. The working fluid is steam, and the jet speed is about 185ft. per second. The efficiencies attainable with any given profile in this turbine are much below those obtained with similar profiles in commercial turbines, and also far below the static efficiencies obtained from the nozzle tester. This turbine works in a region of Reynolds number much lower than commercial turbines or the nozzle tester, and it is interesting to determine if the disparity between the level of efficiencies in the experimental turbine and the nozzle tester is attributable to the effect of Reynolds number.

The first step is to convert the nozzle efficiencies of Fig. 10 into the corresponding values of dynamic

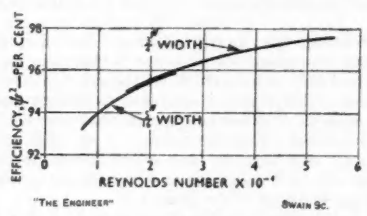


FIG. 10—*Effect of Blade Width on Nozzle Efficiency of Similar Profiles*

blading efficiency. The resultant curves of blading efficiency plotted against Reynolds number are shown by the solid lines in Fig. 11. On comparing them with the corresponding lines of Fig. 10 it will be noticed that the conversion has reduced the efficiencies by about one point and has introduced a very slight divergence between the two curves. As the Reynolds number diminishes, however, this divergence tends to disappear and the two curves practically merge into one again. The two points representing the blading efficiency for the $\frac{3}{4}$in. and $\frac{3}{16}$in. widths of the same prolfie at the appropriate velocity ratio, as found from the experimental turbine, are also plotted in Fig. 11. Compared with the curves derived from the nozzle tester, they show a lower efficiency at a lower Reynolds number, and in themselves they show a falling trend with diminishing Reynolds number. A smooth continuation of the nozzle tester curve would readily pass through both points, as indicated by the dotted line, and it may be suggested that this line can be taken as showing the mutual consistency of the results obtained from the experimental turbine and the nozzle tester.

The weakness of this argument is that the line to be extended is one of considerable and increasing curvature, and fairly wide latitude in the manner of extending it is possible. To overcome this objection the data have been replotted (Fig. 12), the base being a logarithmic scale of Reynolds number and the ordinates a logarithmic scale of the losses, *i.e.*, $(1-\eta_b)$. On these co-ordinates the $\frac{3}{16}$in. blade gives a straight line, while the $\frac{3}{4}$in. blade gives a slightly lower and gently curving line which tends to merge into the other as the Reynolds number diminishes. Extrapolation of either of these lines can be made without dubiety and scores a direct hit on both the turbine test

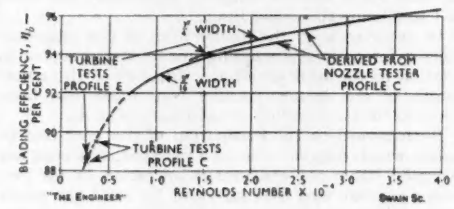


FIG. 11—*Correlation of Blading Efficiency Derived from Nozzle and Turbine Tests*

results. The straight line portion of Fig. 12 indicates the losses varying as the Reynolds number in the power of −0·36.

The curve showing the efficiency as a function of the Reynolds number is a characteristic of the blade profile. Different blade profiles will in general have different characteristic curves, but it is reasonable to expect that if two different profiles have high and nearly equal efficiencies at a high Reynolds number, they will have very similar characteristic curves. It is therefore relevant to compare with the curve for profile C two results for another highly efficient, but quite different profile E, one from the small experimental turbine already mentioned, with a Reynolds number of $0{\cdot}28\times10^4$, and one from a much larger experimental turbine with a Reynolds number of about $1{\cdot}54\times10^{-4}$. These two points are marked on on Figs. 11 and 12, and lie exactly on the curve drawn

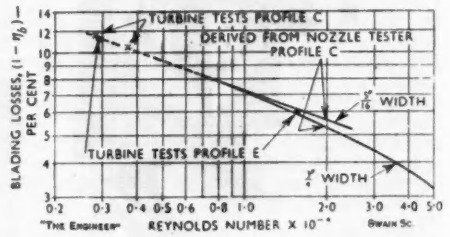
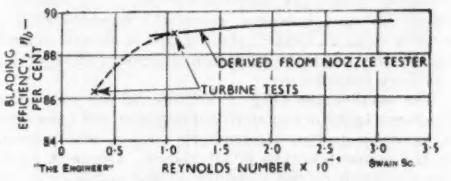


FIG. 12—*Correlation of Blading Efficiency Derived from Nozzle and Turbine Tests*

for profile C, providing a most striking confirmation of the validity of the curve.

Static and dynamic test results can also be compared for reaction blade profile A (Fig. 8). The available data on this profile include, not only results obtained from the nozzle tester and the small experimental turbine, but also tests in a third experimental turbine with operating conditions giving a Reynolds number of about $1{\cdot}06\times10^{-4}$, well within the range of the nozzle tester. In this case a direct comparison can be obtained between static and dynamic test results (Fig. 13). The solid line is obtained by converting the static efficiency of profile A (Fig. 8) into



Reaction blade profile A.

FIG. 13—*Correlation of Blading Efficiency Derived from Nozzle and Turbine Tests*

the corresponding dynamic blading efficiency and plotting on a base of Reynolds number instead of theoretical jet velocity. The two points marked with crosses are the results obtained from the two experimental turbines. The point from the larger turbine falls exactly on the line, this coincidence forming a direct and very striking piece of evidence. The point from the small turbine is also consistent with a reasonable extension of the general trend of the line, although the latter may perhaps be, as suggested earlier, a little on the high side at the lowest velocity.

Conclusion.—The efficiency of turbine nozzles is not determined solely by the shape of the passages. With

passages of geometrically similar shape the flow losses, expressed as a percentage of energy of flow, will be the same if the flow patterns are similar. To achieve similarity of flow pattern, not only must the passages be similar in shape, but also the relative effect of viscosity must be the same. This result is obtained when the size of the passages and the velocity, density and viscosity of the working fluid combine to form equal values of a number which, from its precise analogy with the well-known function used in presenting pipe friction data, may be called the Reynolds number.

The efficiency of a reaction blade profile can be expressed as a continuous function of this Reynolds number. Results obtained from the nozzle tester and various experimental turbines are shown to be mutually consistent and may be considered as approximating to absolute values, provided they are interpreted in the manner indicated.

The dependence of blading efficiency on Reynolds number is a key to much that has not heretofore been clear in turbine performance. The very high efficiencies of water turbines as compared with steam turbines probably are attainable because of the high values of Reynolds number found in the former. Efficiencies of over 90 per cent. have been obtained in steam turbines where the conditions are favourable, namely, high Reynolds number, small clearance loss, and no wetness loss. Again, it is commonly found that the high-pressure unit of a two-cylinder turbine shows an extremely high efficiency as indicated by pressure and temperature readings at inlet and exhaust. Such readings are often viewed with scepticism, but it seems likely that they may be not far wrong, as the turbines in question may have a high efficiency because of the high range of Reynolds numbers in which they work.

Two practical conclusions of great importance are that the highest possible speed of rotation is to be preferred, not only for mechanical, but also for aerodynamical reasons, and that the high-pressure region towards which development is trending is one favourable to the attainment of high aerodynamical efficiencies.

Sixty Years Ago

THE NATIONALISATION OF RAILWAYS

SIXTY years ago, and even more, there was an influential body of opinion in this country that our railways should all be brought under Government management. At that time, and consistently on subsequent occasions, we lent our support to those who opposed the nationalisation of our railways. In our issue of January 28th, 1881, in a leading article, we described the experiences of the German railways since the date on which they had been taken over by the Government. The outstanding fact was that centralisation of railway control had so far failed in Germany, that a Bill had been laid before the Prussian Chamber of Deputies providing for the appointment of District Railway Councillors, and of a National Railway Council for the management of the State lines. The State having become possessed of the railways found that they could not be managed like a Post Office Department, that they wanted a good deal of management, and that central dictation was not the way to secure it. The special management which the railways had had under private enterprise could not be dispensed with, but having dispensed with the boards of directors it had now been found necessary practically to re-create them. By the creation of the District Railway Councillors it was hoped that the wants of the people would be studied and their demands supplied. We doubted whether the plan would succeed, as it would still leave unmet some of the more important functions of the former boards of directors. . . . In addition to this overt sign of the failure of State ownership, we found further evidence of the undesirability of the system in the notorious decrease in the former safety of the German railways, in the reductions in salaries, and in the number of railway workers which had been introduced on the grounds of economy. We commented on the great secrecy which was preserved in Germany respecting railway accidents, the length of time which elapsed before the public became aware of the true number of killed and injured, and the efforts made to hush up all mishaps as quickly as possible. The German Press experienced great difficulty in obtaining correct information concerning railway accidents, so much so that very little was said about them—except when they happened in this country. . . . It is good in these days to read that on at least one occasion in former years the Germans found a central dictatorial system unsatisfactory, and were forced by hard experience to take steps to modify its influence on the national life.

THE LATE MR. J. W. HAMPSHEIR.—We regret to have to announce the sudden death, at the age of seventy-one, on January 8th, of Mr. John White Hampsheir, director and general manager of Keith-Blackman, Ltd., London. Mr. Hampsheir joined the company in 1892, became secretary in 1905, was elected to the board in 1921, and appointed general manager in 1925.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

The United States Steel Market

Active conditions continue to rule in the United States steel market, but the price position seems to be well in hand. It is reported that an advance of 1 dollar has been made in the Chicago district on pig iron by one furnace for first-quarter delivery, increasing the quotation to 24 dollars for No. 2 foundry, 24·50 dollars for Bessemer, and 23·50 dollars for basic. The other pig iron producers in the Pittsburg and Chicago districts continue to quote the old price. Some blast-furnaces which had been expecting to close down in January have remained in operation. In Buffalo only one furnace is idle owing to repairs and the Bethlehem Steel Corporation is keeping all its five blast-furnaces in that district in operation. It has been announced now that one of the blast-furnaces to be constructed by the Bethlehem Steel Corporation in 1941 will be erected at Buffalo, at a cost stated to be between three-quarters and one million dollars. The capacity is to be about 1000 tons daily. The scrap market shows little change and the price is kept at 19·50 dollars to 20 dollars Eastern Pennsylvania and 22 dollars to 23 dollars at Pittsburg. Railway selected scrap has sold at 23·50 dollars. The production of steel has declined slightly and the latest figures give it at 96 per cent. average for the whole trade, with the Chicago district working at an average of 99 per cent. A brisk demand has sprung up from the automobile industry for sheets and strip, but apparently delivery cannot be obtained in less than twelve to thirteen weeks. Four of the United States railways lately have placed orders between them for 70,000 tons of rails. There has been an active general demand also and it is reported that stocks have been accumulated sufficient to maintain the stockholders' reserves for the whole of the first quarter. The tin-plate mills are operating at only 45 per cent. to 50 per cent. of capacity, while the sheet mills have risen to 85 per cent. for hot rolled, 80 per cent. for cold rolled, and 83 per cent. for galvanised sheets. Export prices have recently been advanced in some cases by 2 dollars per ton. Plates, sections and sheets are now quoted at 2·35 dollars to 2·45 dollars per 100 lb., f.a.s., and concrete reinforcing bars at 2·35 dollars, f.a.s.

The Pig Iron Market

The growing demand for foundry iron has been one of the features of the market during the past few weeks. It has been chiefly noticeable in the high phosphoric foundry department, and more of this description has been produced to meet consumers' needs. The increase is traceable to the improved position at the light castings works. Many of the foundries in this branch have obtained Government work and at the same time there has been an active demand for certain builders' supplies. This demand has not been sufficient to create busy conditions at the light castings foundries, but it has greatly improved the position of this industry, which from the time of the outbreak of the war has not shared in the general activity of the iron and steel trades. A natural consequence of this development is that the manufacturers of high-phosphoric iron are busier than they have been for a long time. The Derbyshire and Northants blast furnaces are the principal suppliers of this description of foundry, and, in addition to catering for the foundries on the North-East Coast, where little Cleveland foundry is being produced, they are also serving the Scottish consumers. The heavy engineering and machine tool firms are all fully employed, and their requirements of low-phosphoric pig iron are important. This is not obtainable with the same freedom as in the autumn, and the Control is carefully supervising its distribution as well as that of hematite. For certain classes of work, engineering firms are using low-phosphoric or refined pig iron where normally they would have used hematite. Supplies of the latter, although not scarce, are sufficiently tight to cause the Control closely to watch its distribution and use both in the case of home-produced and imported pig. The production of basic iron has reached a high level and is helped by considerable imports. The position, therefore, does not cause any anxiety, in spite of the large tonnages passing into consumption.

The Midlands and South Wales

Busy conditions rule in the Midland steel industry, and most firms are anticipating an even heavier call upon their resources than occurred in the last quarter of 1940, as Government Departments have extensive programmes of work in hand which will require huge quantities of steel. The expansion recently noticed in the demand for alloy steels has progressed, and most of the steel works have considerably increased the proportion of this class of steel which they manufacture. So large is the call from the armament makers that it seems probable that even so the production will have to be further expanded. The one weakness in the position, and this is only comparative, is in the demand for structural steel, where users of heavy joists are for the moment not taking such large tonnages. The constructional engineers, however, have good prospects of obtaining more Government contracts and this should result in a renewed demand for the heavier sizes after the slight falling off. The pressure for the smaller sizes has at no time relaxed and the re-rollers are experiencing a busy time, the whole of their production passing rapidly into use. This latter industry is in a better position than has been the case for many months, and is getting regular supplies of billets as the heavy home production is being supplemented by imports from America and certain Empire countries. One of the steadiest features of the market is the bar iron section, which for a long time was rather neglected. The call for this class of material, however, has grown steadily during the past month or two owing to a number of orders for steel being diverted to the ironworks who can give more speedy delivery. A number of the works are now behind with deliveries and are not anxious to take on fresh business before clearing up some of these arrears. The engineering works are large consumers of steel bars. The market in South Wales does not present any fresh feature. There is a strong demand for all descriptions of iron and steel, and production is maintained at a high rate. Billets and sheet and tin-plate bars are in request, and the production of the latter, although it has been increased lately, has been barely sufficient to meet the requirements of the tin-plate makers.

The North-East Coast and Yorkshire

Adequate supplies of raw materials are reaching the steel works on the North-East Coast and outputs have been maintained at a high rate. Pressure for supplies from most classes of consumers continues to increase. The demand for munitions is growing and is likely to expand further during the next few months, whilst orders for shipbuilding steel are being pressed upon the works. There has been some decline in the demand for heavy joists and sections, but apart from this any movement has been in the direction of increased requirements. The works producing billets are operating at capacity, and although production is at a high level, imports are necessary to bridge the gap between British production and consumption. There is no tightness in this section of the trade and all the re-rolling mills are receiving good supplies, although a considerable amount of the material now being used has been sent in from the United States. It is doubtful if the plate mills have ever been so busy as during the past week or two, since, not only are big tonnages required for the shipyards, which have an enormous amount of work in hand, but the boiler and tank makers have been pressing for supplies and have taken all the quantities they have been able to obtain. Colliery steel has also been in urgent demand and the pressure for this material is likely to continue in the absence of sufficient timber for colliery purposes. The Yorkshire iron and steel works are operating at capacity and there is considerable pressure from consumers anxious to obtain supplies of basic steel. There is great activity at the acid carbon steel works and by far the greater part of the production is being absorbed by priority users. Firms engaged upon ordinary commercial work find it difficult to secure their full requirements.

Copper and Tin

The copper position in Great Britain has not developed any fresh feature. Consumption is on a heavy scale, but supplies have been sufficient to meet the war demand. Firms engaged upon non-essential work frequently have to go short of metal, but on the whole distribution amongst all classes of consumers is well maintained. In the United States the position remains somewhat tight, and the producers continue to allocate copper to their customers. This seems to be a form of rationing, but the demand in that country is apparently growing, as the armament programme develops. The domestic price is retained at 12c., and the United States Government is discouraging any effort to raise it above that level. By keeping it pegged, however, some of the higher cost producers are prevented from coming into operation. There is fresh talk of the United States buying copper from Chile, but, on the other hand, South American countries have bought copper in the United States out of bond. Exports of all copper from the United States, including semi-manufactured and manufactured metal, are now subject to licence, and so far no licences have been issued. Following President Roosevelt's inaugural speech, the export price of copper jumped from 10·25c. to 10·50c., and the domestic price remained unaltered at 12c. . . . Tin has been a quiet and steady market in Great Britain and the fluctuations have been only a few shillings. No export licences are being granted for the time being, and no development of interest has occurred in the market. The contango has declined to £1 as a result probably of some fairly good buying of cash tin by consumers, who are understood to be requiring the metal for the manufacture of alloys.

Lead and Spelter

Although there is a heavy demand for lead in Great Britain, supplies remain regular and apparently ample. The battery and cable makers are extremely busy and take up considerable quantities, most of their work being for the Government. Other trades are not so actively employed, although in no case is there any real slackness. Steady conditions also characterise the market in the United States. Prices there have not altered and the domestic quotation is 5·50c. New York. The demand appears to be growing under the impetus of the rearmament programme, but production is on a good scale and the situation is described as being well in hand. Stocks in the United States are only moderate, but there seems no apprehension in spite of the expanding demand that the position will become tight. . . . Whilst the world situation in spelter remains stringent, adequate supplies continue to reach Great Britain and there is no sign that the war effort has been impeded by any shortage of the metal. In the United States, however, the position is extremely tight, and it is practically impossible to obtain spelter for export. There is an enormous domestic demand and practically no surplus appears to be available for overseas markets. Japan, who has been offering high prices for spelter for some time without success, has now turned her attention to buying re-melted spelter and is said to have offered 13c. f.a.s. and even higher. Re-melted metal, however, is subject to an export embargo and it seems doubtful whether Japan's requirements will be satisfied from the United States. One of the chief reasons for the heavy demand there is that the brassmakers are exceptionally busy on remarmament orders. The official price remains unaltered at 7¼c., East St. Louis.

Notes and Memoranda

Rail and Road

IRON SHORTAGE IN SWITZERLAND.—Dearth of iron in Switzerland has led to the suggestion that rails should be removed from railways of secondary importance, especially those that do not cover their operating expenses.

A CENTENARY.—The North of England Railway, which connected Darlington with York, celebrated its centenary on January 4th. The running of two coal trains from Darlington to York depôts marked the initial journey in 1841.

GAS FROM SEWAGE.—The Stockholm City Tramway Company is experimenting with the use of methane gas obtained from the city's new sewage disposal works. The capacity of the methane gas plant in the works is to be increased in order to produce an extra supply of the gas, which will be distributed in steel drums under high pressure.

EXTENSIONS IN IRAN.—The Government of Iran has decided to construct a line of railway to connect the important city of Shiraz (population 120,000) with the port of Bushire on the Persian Gulf. Shiraz is the centre of one of the best-known carpet-making and wine industries in Iran, but it is situated on the Iranian plateau and is 5100ft. above sea level.

STATION LOUDSPEAKERS.—It was recently revealed that at Crewe railway station there are no fewer than ninety loudspeakers distributed over the whole of the station. On Platform 1 there are twenty; Platform 2, two; Platform 3, eleven; Platform 4, sixteen; Platform 5, fourteen; and Platform 6, seven. The loudspeakers are normally used for giving information to passengers between 8 a.m. and midnight.

THE LIGHT RAILWAY TRANSPORT LEAGUE.—The Light Railway Transport League, whose main objective is advocating the retention, improvement and extension of tramways and other light railways, has appointed Mr. H. B. Priestley, of Gainsborough, Lincs, to be its information officer for the collation and preservation of historical and operational data regarding tramways, past and present. Mr. D. S. Barrie has been appointed press officer to the League.

A GAUGE CONVERSION.—In order to improve an east-and-west route in China, the Japanese have converted the Shihchiachwang-Taiyuan section from metre to 4ft. 8½in. gauge. It is probable that the Tatung-Taiyuan-Pukow metre-gauge line will also be converted to standard gauge, if this work is not yet actually in hand. It forms a third important north-south line, connecting the Peiping-Kalgan-Paotou line with the Lunghai Railway at Tungkwan, just south of Puchow.

TRANSPORT IN RUSSIA.—Everywhere the petrol problem is taxing the ingenuity of transport engineers, and experiments are reported from the Soviet Union, where lignite is being tried as a fuel for use in producer gas vehicles. Whatever the weather, the performance of vehicles working on lignite is said to be as good as those working on benzine. The Republic of Kazakhstan produces suitable lignite, and funds have been allocated for the building of workshops for the conversion of vehicles to run on this fuel.

BRAZIL RAILWAYS.—The expropriation of the Mogyana Railway has been confirmed by a Presidential Decree dated September 2nd. On various occasions, and especially during the financial crisis of this company, some of the shareholders desired that the Government should take over the railway. A concession has been granted to the Brasunido Sociedade Anonyme for the construction of a metre-gauge electric railway mainly for the transport of minerals from Camapuan (ex Joao Ribeiro), on the Parapeba line of the Central Railway, to Andrelandia, situated on the trunk line of the Rêde Mineira de Viaçao. The concession also provides for port works at Angra dos Reis for the shipment of the minerals.

Air and Water

A RHINE PORT NEAR BASLE.—The new port on the Rhine at Birsfelden, near Basle, built with a view to relieving the congested ports of St. Johann and Kleinhüningen, is now completed, and ready for inauguration as soon as river traffic is resumed. Work on the new port was begun in December, 1937.

LIFEBOAT SERVICE.—It was recently announced that during 1940 lifeboats rescued 2052 lives and helped to save 87 ships from destruction. Launches numbered 1078, and 638 were to vessels in distress on account of the war. Many launches were made to aircraft down in the sea. These activities gave the lifeboat service its busiest year since its inception 117 years ago.

NEW VESSEL FOR LAKE THOUNE.—A new motor vessel, the "Oberhofen," has been placed in service on the lake of Thoune. This is one of the four ships which conveyed visitors between the two sections of the National Exhibition at Zurich in 1939. It carries 155 passengers, and is equipped with a 180 H.P. diesel engine. The services on the lakes of Thoune and Interlaken are operated by the Lötschberg Railway.

GAS FOR SMALL RIVER CRAFT.—An interim report of the Gas Traction Development Committee embodies a suggestion for the use of methane (CH_4) as fuel for small craft. It could be carried either in the compressed form, or, more attractive still, in the liquefied state. The gas can be obtained from collieries, coke ovens, or sewage farms, while it is available in the natural state in large quantities in certain areas in this country. Methane can be used for the operation of internal combustion engines as an alternative to petrol, coal gas, or producer gas, and the report contains an estimate of the cost of compressing, which, taking 140 cubic feet as equivalent to a gallon of petrol, works out at 3·8d. per gallon equivalent. Cylinders of compressed gas or bottles of liquid gas might even be carried.

U.S. SHIPYARD PURCHASE.—The *Journal of Commerce* reports that an American-Norwegian syndicate, headed by Hr. Alfred Holter, a refugee Norwegian industrialist, has bought the shipyard at Old Groton, Connecticut, which has been closed since the last war. It is proposed to build a fleet of fast cargo steamers there for British and allied shipping. The plans call for vessels of 9500 tons, the first of which, Hr. Holter said, would be completed within eleven months.

FISHING FLEET TO USE WOOD-TAR FUEL.—Owing to petrol shortage in Sweden, the Swedish manufacturers of crude oil engines have designed equipments to use wood tar in place of heavy fuel oil. Practical tests on a considerable scale have been carried out by the fishery organisations in collaboration with the Royal Swedish Academy for Engineering Research with satisfactory results. The State Fuel Commission expects to supply the fisheries with 8000 tons of wood tar during 1941.

A ROUND-THE-WORLD SERVICE.—Plans are afoot for the purchase by the Isthmian Steamship Line of eight "C-3" type cargo vessels for use in its round-the-world service. Negotiations for the purchase of these vessels were begun over a year ago, but were suspended when the war in Europe broke out. Late last summer, however, the steamship company renewed its attempt to get this fleet of ships. With speedy vessels in service it would be practical to make a substantial reduction in the previous 170-day voyage round the world as made by the old ships. Contracts for the eight ships were awarded to the Western Pipe and Steel Company, San Francisco, and the Seattle-Tacoma Shipbuilding Corporation, Seattle, more than two months ago by the Maritime Commission, and recent contract records of the Commission indicate that the vessels are for the Isthmian Line.

Miscellanea

A DISCOVERY OF WOLFRAM.—Deposits of wolfram ore have been discovered in Jugoslavia along the Adriatic coast. The country has produced hitherto only small quantities of the metal.

DALTON'S APPARATUS.—Scientific apparatus used by Dalton, the chemist and mathematician who propounded the atomic theory of chemical action, are among treasures believed to have been destroyed in a recent raid in Manchester. The apparatus was one of the show pieces at the home of the Literary and Philosophical Society.

THE SCRAP SURVEY.—The National Survey undertaken by the Iron and Steel Control of the Ministry of Supply of the resources available in Somerset and Glamorgan has been concluded, and investigations have been begun in Lancashire and Yorkshire. Work has also been started in London, Scotland, and the North of England.

SOUTH AFRICAN ALUMINIUM TRADE CONTROL.—The import into the Union of South Africa or the Mandated Territory of South-West Africa of any aluminium in the form of ingots, bars, pellets, strips, circles, and extruded sections, sheets, and foil, is now prohibited, except under a permit issued by or on behalf of the Minister of Commerce and Industries.

BAN ON IRON AND STEEL IMPORTS.—The Indian Government has prohibited the import into British India of various types of iron and steel, including ingots, plates, sheets, tubes, hoops, wheels, castings, and bolts. The ban does not affect iron and steel despatched on through consignment to India not later than January 1st, 1941, or covered by open general licence or special licence.

COTTON WASTE.—To ensure that certain qualities of cotton waste necessary for carrying out Government and export orders shall not be used for other purposes, where substitution is possible, by classes of waste which are in ample supply, the use or consumption of cotton waste, with certain exceptions, will be subject to licence. An Order to this effect has been issued by the Ministry of Supply.

TECHNOLOGY IN SOUTH AFRICA.—Lecturing recently before South African Associated Scientific and Technical Societies, Dr. Vernon Bosman estimated that 10,000 factories were now operating in the Union. That was impressive, but the country's future prosperity depended on the steady and continuous development of productive activity. South Africa could not yet be numbered among the big industrial countries of the world, but its tremendous resources of raw materials presented a solution, although it entailed selective development of those resources.

AMERICAN COPPER.—Available supplies of copper in the United States for the last quarter of 1940 exceeded consumers' requirements for the same period by 81,000 short tons, according to a survey of the Bureau of Mines, United States Department of the Interior. The Survey indicated that consumers' requirements for refined copper for domestic and foreign trade were expected to total 361,000 tons during the three-month period, whereas the available supply aggregated 442,000 tons. Of the 64 concerns reporting, 13 indicated shortages. Anticipated requirements of this group totalled 62,100 tons against an available supply of 49,700 tons.

SPELTER FOR JAPAN.—Mr. C. Donald Dallas, president of Revere Copper and Brass, Inc., has warned U.S.A. consumers that the spelter "which we allowed to be delivered to Japan was so badly needed by our brass manufacturers that fabricating plants all over the country are being forced to curtail production schedules when they should be increasing." Mr. Dallas also said that a shortage of domestic copper is likely to occur in the early part of this year. National defence programme and ordinary industrial needs for copper are running at an annual rate of 1,300,000 tons, while copper supply from domestic sources is somewhere around 1,000,000 tons. The difference would have to be imported from American-owned Latin-American copper properties.

CHROME ORE.—The Imperial Institute has recently issued a new title in its series of monographs on mineral resources. It deals with chrome ore and chromium, and covers every aspect of its subject whilst paying special attention to the numerous and high-grade deposits of the mineral in the Empire, which is well placed to provide supplies of this mineral. Southern Rhodesia and the Union of South Africa are among the world's leading producers. India, too, possesses important deposits of chrome ore of good metallurgical grade, and Cyprus and Sierra Leone also contribute to the total output. About one-third of the world's output comes from British countries and two-thirds is produced by companies under British control.

Personal and Business

HORACE BOOT AND PARTNERS, Ltd., inform us that their address is now Clarefield Court, Pinkney's Green, Maidenhead.

MR. W. A. AKERS and Mr. W. F. LUTYENS have been appointed additional directors of Imperial Chemical Industries, Ltd.

MR. W. J. JONES has been appointed Director of the Electric Lamp Manufacturers' Association in succession to Mr. C. W. Sully, who recently retired.

MR. W. H. TURNER has accepted an invitation to serve as the Ministry of Supply Regional Representative in the Midland area, with headquarters at Birmingham.

MR. R. A. THWAITES, engineer and manager of the North Wales Power Company, has been appointed to the National Consultative Committee of the Central Electricity Board.

CALLENDER'S CABLE AND CONSTRUCTION COMPANY, Ltd., informs us that its Southampton office is closed. The postal address of the local office is Upper Brook Street, Winchester. Telephone number, Winchester 323.

BROADWAY ENGINEERING COMPANY, Ltd., Carlisle Road, Hendon, London, informs us that it has concluded agency agreements with Criterion Machine Works, Los Angeles; Bakewell Manufacturing Company, Los Angeles; Hunter Engineering Company, Riverside, California; and Rex Products, Detroit, under which it has the sole rights for Great Britain of dealing with the products of those companies.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Bradford Engineering Society

Monday, Feb. 10th.—Technical College, Bradford. "Some Common Types of Water Supplies and their Influences in Steam Plant," W. F. Gerrard and T. Millican. 7.15 p.m.

Fuel Luncheon Club

Thursday, Feb. 6th.—Connaught Rooms, Great Queen Street, Kingsway, W.C.2. Luncheon. "The War Damage Bill and its Relation to the Fuel Industries," Captain H. F. C. Crookshank. 12.40 for 1.10 p.m.

Institute of Physics

Saturday, Jan. 25th.—Research Laboratories of the General Electric Company, Ltd., Wembley. Conference on Industrial Radiography. 2 p.m.

Institution of Automobile Engineers

Saturday, Jan. 25th.—LUTON CENTRE: George Hotel, Luton. "Producer Gas for Road Vehicles," M. Platt. 2.45 p.m.

Institution of Electrical Engineers

Monday, Jan. 27th.—N.E. CENTRE: Neville Hall, Westgate Road, Newcastle-upon-Tyne. "Voltage-operated Earth-leakage Protection," T. C. Gilbert. 6.15 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Feb. 11th.—39, Elmbank Crescent, Glasgow, C.2. "Experiments in Rough Water with a Single-screw Ship Model," J. L. Kent and R. S. Cutland. 6.30 p.m.

Institution of Mechanical Engineers

To-day, Jan. 24th.—Storey's Gate, Westminster, S.W.1. Presentation of James Watt International Medal. Lowe Gray Lecture, "Progress in Marine Engineering as Influenced by the Classification of Ships," S. F. Dorey. 2 p.m.

Saturday, Jan. 25th.—YORKSHIRE BRANCH: The University, Leeds. "Power and Combustion," A. C. G. Egerton. 2.30 p.m.

Monday, Feb. 3rd.—N.E. BRANCH: Mining Institute, Neville Hall, Newcastle-upon-Tyne. "Progress in Marine Engineering as Influenced by the Classification of Ships," S. F. Dorey. 6 p.m.

Junior Institution of Engineers

Saturday, Jan. 25th.—39, Victoria Street, S.W.1. "Protective Coatings on Metals," P. A. Cartwright. 1.30 p.m.

Manchester Association of Engineers

Saturday, Jan. 25th.—Engineers' Club, Albert Square, Manchester. "Recent Developments in Cast Non-ferrous Engineering Materials," F. Hudson. 2.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Wednesday, Jan. 29th.—STUDENT SECTION: Bolbec Hall, Newcastle-upon-Tyne. "Burmeister and Wain Diesel Engines," K. I. Overgaard. 6.45 p.m.

Friday, Jan. 31st.—Mining Institute, Newcastle-upon-Tyne. "Effect of Some External Factors on the Performance of Single-screw Ships," A. Kari. 6 p.m.

North of England Institute of Mining and Mechanical Engineers

Friday, Feb. 14th.—Royal Station Hotel, Neville Street, Newcastle-upon-Tyne. Dinner. 7 for 7.30 p.m.

Royal Institution of Great Britain

Tuesday, Jan. 28th.—21, Albemarle Street, W.1. "Diffraction," Sir W. Bragg. 2.30 p.m.

Royal Society of Arts

Wednesday, Jan. 29th.—John Adam Street, Adelphi, W.C.2. "Municipal Manufacture of Humus from Habitation Wastes," F. C. Temple. 1.45 p.m.